POWER

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ELY C. HUTCHINSON, *Editor*

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1932 PREPARES THE WAY FOR 1933

Anno Domini nineteen thirty-two was notable in the power field.

It has seen an extraordinary concentration of progress in the simplification of power plant operation and reduction of power generating costs.

It has advanced technique to the point where the best power engineering hitherto available mostly to the large central stations, is at hand now for the low cost production of power in isolated plants for industry as well as in public institutions and office buildings.

Actual business, while considerable, has suffered noticeably from a lack of buying courage in the face of large possible savings from comparatively small investments. Lack of credit has retarded progress in this direction also but nothing like so much as popularly supposed.

The Robertson Committee on Industrial Rehabilitation is proving effective in some localities as a means of helping to reestablish industrial movement. Its full influence however will not be reached until this year.

In the record for the past year there are many points of high accomplishment and reasons for encouragement. The whole field of power engineering has moved forward on a front as wide as, and in many respects wider than, ever before.

So, while we review in this number the progress of nineteen thirty-two, we greet the new year confident in the knowledge that the business of power generation is vitally necessary to world progress and that it is ready.

ISOLATED POWER

LEADS ACTIVITY IN

STEAM PLANT

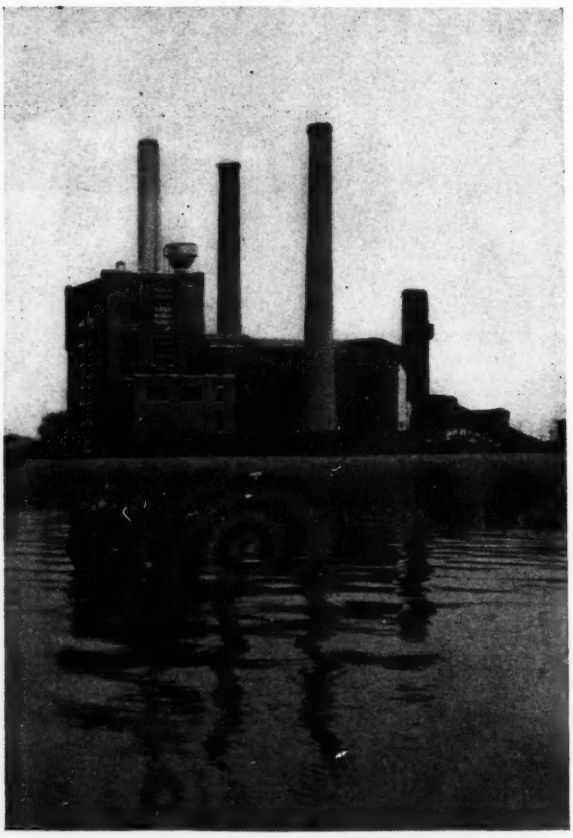
THE almost entire absence of new utility power-plant projects during the past year has made it impossible to discern any particular trend or changes in the design of new power stations. The Buzzard's Point plant of the Potomac Electric Power Co. near Washington, D. C., is the only new plant project initiated during 1932. This new plant it is reported, will have an ultimate capacity of 400,000 kw. An initial unit of 35,000 kw. has been ordered which will operate at 720 lb. pressure and 835 deg. F. The Dodge City plant of the Kansas Power Co. was the only new utility plant placed in operation. In this plant two 6,000-sq.ft. boilers supply 400-lb. steam at 750 deg. F. to a 7,500-kw. bleeder turbine. Central station generating capacity added during the year amounts to 426,500 kw.

No installations for pressures as high as 1,200 to 1,400 lb. were initiated or completed, but the opinion seems to be that, when growing load eventually requires new construction in the central station field, the pressures and temperatures will be limited to about 1,400 and 850 deg. Interest in higher pressures continues, however, as evidenced by the support given to investigations of critical-pressure series-flow boilers at Purdue University.

The new Port Washington plant of the Milwaukee Electric Railway & Light Co. which was initiated in 1931 is still under construction. In this plant is to be installed an 80,000 kw. unit to operate at a steam temperature of 840 deg. F. The San Antonio Public Service Co.'s plant at Conception Road is the only other central station plant having such severe steam conditions. It operates at 1,518 lb. pressure and 810 deg. F. The State Line plant of the Chicago District Electric Generating Corp. has on order two large units that will operate under similarly severe steam conditions. The 150,000 kw. tandem unit for this station has been completed and shop tests made; the other unit, a 125,000 kw. tandem turbine, is still under construction. Delivery of both these units has, however, been postponed.

Three utilities are making additions to their plants. The Philadelphia Electric Co. has ordered a 165,000 kw. tandem turbine for installation in their Richmond station. This unit, however, probably will not be delivered until 1934.

The Hawaiian Electric Co. is installing in their plant in Honolulu a 10,000-kw. "top" to their older plant. The new turbine will operate at 3,600 r.p.m. on 650 lb. steam at 825 deg. F. and will exhaust to the older units in the station. This is the second station to superimpose a 650-lb. 825 deg. unit on the older part of the plant. The first installation of this kind was made at the Burlington plant of the Public Service Electric & Gas Co. where an 18,000 kw. 3,600 r.p.m. went into operation last year. This new unit forms a "top" on the old plant which operates at 200 lb. pressure.



An 18,000-kw. turbine, the largest 3,600-r.p.m. unit, has been placed in operation at the Burlington station of the Public Service Electric & Gas Co.

By selecting 650 lb. rather than 1,400 for the new unit it was possible to operate without reheating, in view of the fact that the old low-pressure low blade-speed turbines can run with high percentage of moisture in the exhaust without undue erosion. It is expected that the station heat consumption rate will be reduced by more than 30 per cent.

It may be that these two installations mark the start

CONSTRUCTION

of a trend toward the use of 650-lb., 825-deg. units in the rehabilitation of older stations, instead of the use of 1,200 to 1,400 lb. installations that have been used for this purpose in several plants. The 1,200 lb. installation requires installation of expensive reheating equipment, whereas the 650 lb. unit can be installed without reheat and, therefore, makes a somewhat less expensive addition of plant capacity while at the same time the overall station heat rate is materially improved. With steam temperatures of 850 deg. now fairly well established it may be that new plants will be built with pressures in the 500 to 800 lb. range.

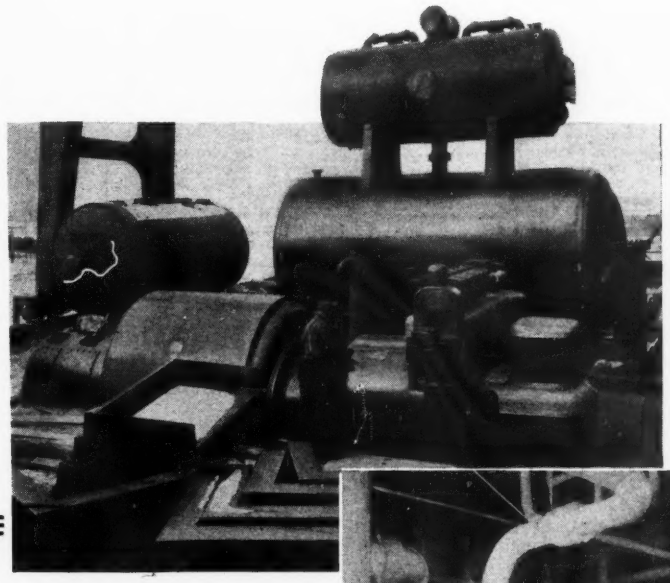
There is some possibility that plants other than the 1,000 deg. experimental installation of the Detroit Edison Co. will be built for operation at steam temperatures of 900 to 1,000 deg. This would make it possible to operate without reheating at pressures up to 700 or 800 lb.

Five plants are in operation utilizing steam temperatures of 835 deg., not including the two steam engines installed in the Philip Carey Company's plant. There are now in operation or under construction twelve turbines designed for 825 deg. in eight plants. From these plants in operation no adverse operating reports have been received.

Additional plant capacity was placed in operation in five utility stations. These include a 75,000-kw. installation at the Kearny plant of the Public Service Gas & Electric Co. The mercury vapor installation at this station is progressing rapidly and it is reported that the turbine and mercury boilers have been delivered. The mercury unit is to operate at 125-lb. pressure and 958-deg. and the steam generated by the mercury exhaust will be used in the 350-lb., 750-deg. section of the station.

Construction work on the General Electric Company's new 20,000 kw. mercury vapor plant at Schenectady is well under way and will probably go into operation some time early this year. More detail is given concerning this plant in the article on mercury vapor installations, page 34. This plant will be the first outdoor station to go into operation. The only other outdoor station planned is the Herndon plant of the Joaquin Light & Power Corp. Construction on this station has been postponed.

The Brooklyn Edison Co. placed in operation the 320,000 kw. addition to its Hudson Ave. plant. This addition contains two 160,000 kw. units and eight new boilers each designed for a maximum steaming capacity of 530,000 lb. per hour. These new units complete this station raising its capacity to 770,000 kw. and mak-



The 6,000-kw. steam turbine at the General Electric Company's mercury vapor plant at Schenectady

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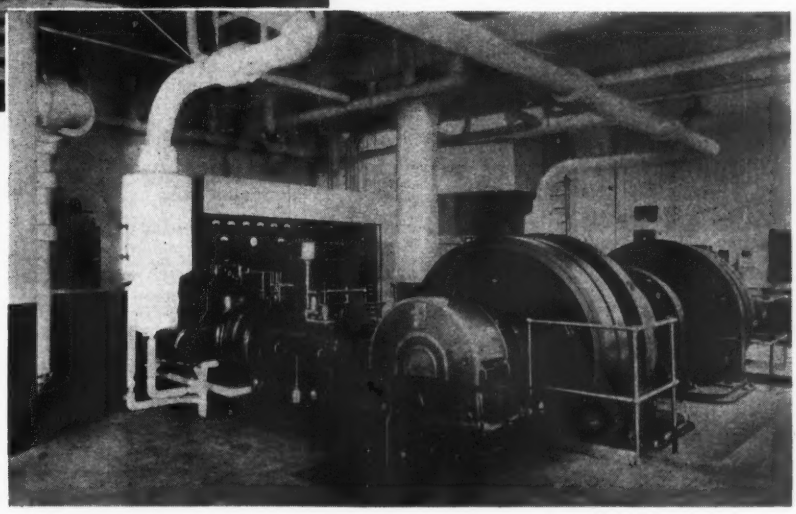


This 350-kw. plant supplies steam and by-product power to the Cashman Laundry

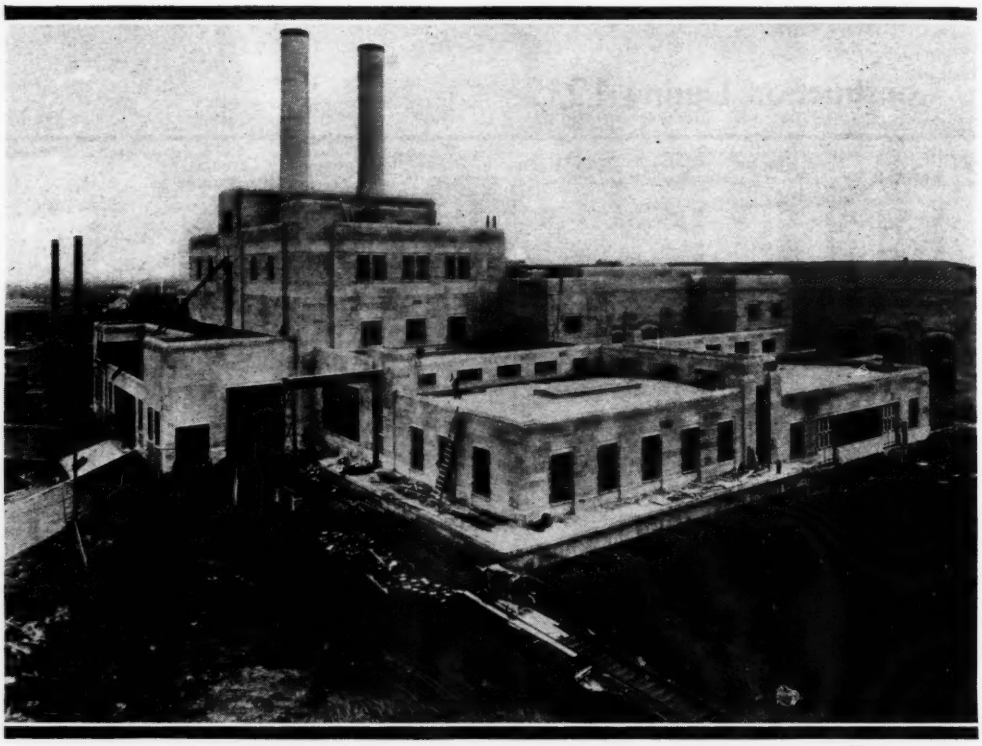
Steam Plants Placed in Operation or

Company	Name of Plant and Location	Boilers: Number	Boilers: Max Capacity, Lb. per Hr., Ea.	Boilers: Pressure, Lb. per Sq. In.	Steam Temp. Deg. F.	Economizers: Number	Economizers: Surface Sq. Ft.	Air Preheaters: Number	Air Preheaters: Surface, Sq. Ft.	Firing Method
CENTRAL STATION PLANTS										
Milwaukee Electric Railway & Light Co.	Port Washington	1	690,000	1,390	840	..	.....	2	60,500	Bin P. C.
Chicago District Electric Gen. Corp	State Line	3	500,000	1,200	825	..	.....	..	.....	Gass
Potomac Electric Power Co.	Buzzard Point	2	375,000	720	835	..	.....	..	.....	.....
Public Service Electric & Gas Co.	Burlington	1	29,800*	650	850	1	.....	1	.....	Oil
Hawaian Electric Co.	Honolulu	1	9,380*	650	825	..	.....	..	.....	.....
Boston Elevated Railway	Lincoln	4	164,000	450	750	..	.....	4	37,800	P. C.
Philadelphia Electric Co.	Richmond	..	.....	375	825	..	.....	..	.....	.....
Brooklyn Edison Co.	Hudson Ave.	8	530,000	400	730	8	22,400	..	.....	U. Stoker
Kansas Power Co.	Dodge City	2	72,000	400	750	..	.....	2	9,880	Gas and Oil
Public Service Electric & Gas Co.	Kearny	..	.....	350	750	..	.....	..	.....	.....
		1	Mercury	125	958	..	.....	..	.....	.....
General Electric Co.	Schenectady	..	Mercury	125	958	..	.....	..	.....	.....
		..	300,000	400	760	..	.....	..	.....	P. C.
Otter Tail Power Co.	Kidder	..	.....	.....	.....	..	.....	..	.....	.....
Washington Gas Light Co.	East Station	1	5,000*	200	488	..	.....	..	.....	.....
Duluth Steam Corp.	Duluth, Minn	4	90,000	425	...	..	.....	4	6,750	P. C.
MUNICIPAL PLANTS										
Municipal Electric Light & Power of Richmond	Richmond, Ind.	2	96,000	450	750	..	.....	2	4,720	U. Stoker
Colorado Springs Municipal Plant	Colorado Springs, Colo.	1	65,000	430	750	..	.....	1	9,880	Gas
McPherson Municipal Plant	McPherson, Kansas	1	30,000	400	660	..	.....	..	.....	Gas
Hinsdale Municipal Plant	Hinsdale, Ill.	..	.....	215	493	..	.....	..	.....	.....
Dover Municipal Plant	Dover, Del.	..	.....	160.	...	..	.....	..	.....	.....
Brookings Municipal Plant	Brookings, So. Dakota	..	.....	165-	473	..	.....	..	.....	.....
St. Bernard Municipal Plant	St. Bernard, Ohio	..	.....	150-	...	..	.....	..	.....	.....
Pasadena Municipal Plant	Pasadena, Calif.	2	210,000	460	750	..	.....	2	37,000	Oil
INSTITUTIONAL PLANTS										
Ohio State Penitentiary	Columbus, Ohio	2	45,000	450	700	..	.....	..	.....	U. Stoker
U. S. Government	Triangle Heating Plant	6	237,000	400	...	..	.....	..	.....	U. Stoker
Washington Univ. School of Medicine	St. Louis, Mo.	4	5,531*	250	...	..	.....	..	.....	Chain Grate
Longview State Hospital	Cincinnati, Ohio	4	29,000	250	...	..	.....	..	.....	U. Stoker
State University of Iowa	Iowa, Iowa	1	6,000*	225	622	..	.....	..	.....	U. Stoker
University of Texas	Austin, Texas	..	.....	200	488	..	.....	..	.....	.....
Williams College	Williamstown, Mass.	2	32,640	180	...	..	.....	..	.....	U. Stoker
Swarthmore College	Swarthmore, Pa.	1	29,200	178	...	..	.....	..	.....	U. Stoker
Queens County Hospital	Queens, N. Y. C.	4	32,000	175	...	..	.....	..	.....	Oil
Taunton State Hospital	Bristol, Mass.	2	20,000	165	...	..	.....	..	.....	Stoker
Berea College	Berea, Ky.	2	3,840*	160	...	..	.....	..	.....	U. Stoker
Ball State Teachers College	Muncie, Ind.	3	73,800	160	...	..	.....	..	.....	Stoker
Iowa State Teachers College	Cedar Falls, Iowa	2	5,200*	150	...	..	.....	..	.....	Chain Grate
		2	3,120*	....						
Pilgrim State Hospital	Brentwood, L. I.	4	64,000	150	...	..	.....	..	.....	U. Stoker
Vassar College	Poughkeepsie, N. Y.	5	.....	125	...	..	.....	..	.....	U. Stoker
Long Island College Hospital	Brooklyn, N. Y.	..	.....	125	...	..	.....	..	.....	.....
U. S. Military Academy	West Point, N. Y.	..	.....	....	...	..	6,000	..	.....	.....
So. Dakota State College	Brookings, So. Dak.	1	4,570*	....	...	..	.....	..	.....	U. Stoker
University of Notre Dame	Notre Dame, Ind.	4	32,000	135	...	..	.....	..	.....	Chain Grate
New York Hospital—Cornell Medical College Association	New York City, N. Y.	4	79,000	250	...	..	.....	..	.....	Oil
INDUSTRIAL PLANTS										
Blandin Paper Co.	Grand Rapids, Minn.	1	90,000	450	648	1	1,404	1	9,580	Unit P. C.
Jacob E. Decker & Sons	Mason City, Iowa	2	60,000	450	650	..	.....	2	4,000	Unit P. C.
Frostman Woolen Co.	Garfield, N. J.	2	80,000	450	610	..	.....	2	6,500	P. C.
Philadelphia & Reading Coal & Iron Co.	St. Nicholas, Pa.	2	120,000	450	...	2	3,459	..	.....	Trav. Grate
Alex. Smith & Sons Carpet	Yonkers, N.Y.	..	.....	400	...	..	.....	..	.....	.....
Western Electric Co. Inc.	Kearny, N. J.	2	89,250	325	700	2	4,203	..	.....	Chain Grate
City of Detroit, Mich.	Springwells Pumping	2	90,600	380	715	2	2,400	2	9,980	U. Stoker
Pennsylvania Sugar Co.	Philadelphia, Pa.	2	300,000	400	500	2	5,000	2	20,632	Unit P. C.
Taylor Instrument Co.	Rochester, N. Y.	..	.....	400	644	..	.....	..	.....	.....
National Sugar Co.	Hunters Point, L. I.	..	.....	300	500	..	.....	..	.....	.....
Cincinnati Union Terminal	Cincinnati, Ohio	3	100,000	250	...	..	.....	..	.....	U. Stoker
Armour & Co.	West Fargo, N. D.	1	60,000	250	...	..	.....	1	7,350	Unit P. C.
Frostman Woolen Co.	Passaic, N. J.	3	60,000	250	506	..	.....	3	5,600	.....
American Optical Co.	Southbridge, Mass.	1	9,430*	225	497	..	.....	..	.....	Oil
Chicago Union Station	Chicago, Ill.	4	12,100*	200	...	4	4,290	..	.....	Chain Grate
Chase Brass & Copper Co.	Euclid, Ohio	3	37,500	200	540	..	.....	3	4,000	U. Stoker
Knickerbocker Laundry	Long Island City, L. I.	2	4,000*	198	...	..	.....	..	.....	Oil
Columbia Mills	West Pullman, Ill.	1	70,000	175	...	..	.....	1	4,920	Unit P. C.
M. Werk Co.	Cincinnati, Ohio	2	3,750*	160	....	..	.....	..	.....	P. C.
Brunswick Laundry	Jersey City, N. J.	2	4,500*	160	...	..	.....	..	.....	U. Stoker
		2	5,087*							
Cashman Laundry	New York City, N. Y.	2	4,440*	150	...	..	.....	..	.....	Oil
Dow Chemical Co.	Midland, Mich.	1	Dowtherm	50	661	..	.....	..	.....	.....

* Sq.ft. of heating surface.

Under Construction During 1932

Fans: Forced Number	Fans: Forced Capacity, c.f.m.	Fans: Induced Number	Fans: Induced Capacity, c.f.m.	Feed Pumps Number	Feed Pumps Capacity, g.p.m.	Main Units Number	Main Units Type	Main Units Capacity, Kw.	Main Units Bleed Points	Condensers Surface, Sq.Ft.	Condensers Type	Circulating Pumps Number	Circulating Pumps Capacity, g.p.m.	Air Removal	Remarks
2	112,500	2	185,000	..	.....	1	Tandem comp.	80,000	5	52,500	1 pass	2	55,000	Twin 3 stg. jet	Under construction
..	.....	..	.....	..	.....	1	Tandem	125,000	..	.....	.....	..	.....	.....	.....
						1		150,000							
..	.....	..	.....	..	.....	1	Sing. cyl.	35,000	..	.....	.....	..	.....	.....	New project
..	.....	..	.....	..	.....	1	1 cyl. 3,600 r.p.m.	18,000	..	.....	.....	..	.....	.....	Placed in operation
..	.....	..	.....	..	.....	1	1 cyl. 3,600 r.p.m.	10,000	..	.....	.....	..	.....	.....	Exhaust to 3-10,000 kw. units
4	50,000	4	85,000	3	750	1	1 Cyl.	35,000	4	34,000	2 pass.	1	24,000	Twin jet	Placed in operation
												1	16,000		
..	.....	..	.....	..	.....	1	Tandem comp.	165,000	3	.....	.....	..	.....	.....	Delivery scheduled for 1934
7	200,000	16	155,000	6	1,500	2	Tandem comp.	160,000	2	101,000	1 pass.	..	.....	Steam jet	Placed in operation
2	22,000	2	42,000	2	175	1	Cond. turbine	6,000	3	7,500	.....	..	.....	Twin 2 stg. jet	Placed in operation
..	.....	..	.....	..	.....	1	1 cyl. turbine	75,000	..	65,000	.....	..	.....	.....	Placed in operation
..	.....	..	.....	..	.....	1	Mercury	20,000	..	.....	.....	..	.....	.....	Under construction
..	.....	..	.....	..	.....	1	Mercury	20,000	..	.....	.....	..	.....	.....	Under construction
..	.....	..	.....			1	Cond. steam turbine	6,000		.....	.....				.....
..	.....	..	.....	1	250	1	.....	7,500	3	8,000	.....	2	4,000	Steam jet	2-hp. evap. 7,500 lb. per hr.
..	.....	..	.....	..	.....	2	Mixed pres.	1,900hp.	..	Barometric		..	.....	.....	Turbines drive gas compressors
..	.....	4	60,000	2	500	..	.....	.....	..	.....	.....	..	.....	.....	Boilers operate at 235 lb. press. in operation
2	33,000	2	141,500	3	600	1	1 cyl. 3,600 r.p.m.	15,000	3	15,180	2 pass.	..	.....	Steam jet	Under construction
1	79,750	1	86,100	2	150	1	1 cyl. turbine	5,000	2	6,028	.....	1	7,500	2 stg. steam jet	Under construction
..	.....	..	.....	..	.....	..	.....	.....	..	.....	.....	..	.....	.....	.....
..	.....	..	.....	..	.....	1	1 cyl. turbine	2,500	2	3,000	.....	1	3,150	Steam jet	60 hp. aux. set
..	.....	..	.....	..	.....	1	1 cyl. turbine	1,250	..	.....	2 pass.	1	1,950	.....	New switch board
..	.....	..	.....	..	.....	1	1 cyl. turbine	1,000	1	.....	.....	1	1,600	.....	Cooling tower
..	.....	..	.....	..	.....	1	Vert. engine	1,000	..	.....	.....	..	.....	.....	Engine designed for future 250 lb. operation
2	56,500	2	63,000	1	1,000	1	Cond. turbine	25,000	4	.....	1 pass.	1	6,000	2 stg. jets	Placed in operation
												1	13,000		
1	43,900	1	96,500	2	250	1	Cond. turbine	3,000	2	250	.....	2	1,600	Twin steam jet	Under construction
6	.....	6	.....	..	.....	..	.....	.....	..	.....	.....	..	.....	.....	Under construction
3	21,000	..	.....	3	250	2	Non-cond. turbine	600	..	.....	.....	..	.....	.....	.....
						1		1,563							
4	28,000	..	.....	2	12x7x12	1	Engines	187	..	.....	.....	..	.....	.....	.....
						2		250							
..	.....	..	.....	..	.....	..	.....	.....	..	.....	.....	..	.....	.....	.....
..	.....	..	.....	..	.....	..	.....	.....	..	.....	.....	..	.....	.....	.....
2	.....	..	.....	2	.....	..	.....	.....	..	.....	.....	..	.....	.....	.....
1	.....	..	.....	..	.....	..	.....	.....	..	.....	.....	..	.....	.....	.....
..	.....	..	.....	3	.....	1	Engines	100	..	.....	.....	..	.....	.....	Non-condensing
						2		250							
..	.....	..	.....	2	10x6x10	3	Engines	75	..	.....	.....	..	.....	.....	.....
..	.....	..	.....	..	.....	..	.....	.....	..	.....	.....	..	.....	.....	.....
1	.....	..	.....	2	.....	..	.....	.....	..	.....	.....	..	.....	.....	.....
4	.....	..	.....	3	150	1	Non-cond. turbine	625	..	.....	.....	..	.....	.....	.....
3	.....	..	.....	..	520	1	Engines	700	..	.....	.....	..	.....	.....	Non-condensing, in operation
						2		1,350							
1	.....	..	.....	2	.....	1	Cond. turbine	300	..	.....	.....	1	725	Steam jet	.....
..	.....	..	.....	..	.....	1	Vert. engine	300	..	.....	.....	..	.....	.....	.....
..	.....	..	.....	..	.....	1	Non-cond. turbine	300	..	.....	.....	..	.....	.....	.....
						2		1,000							
1	.....	1	.....	..	.....	2	1 cyl. 3,600 r.p.m. turb.	1,250	1	.....	.....	..	.....	.....	.....
4	15,000	..	.....	2	200	..	.....	.....	..	.....	.....	..	.....	.....	.....
2	.....	..	.....	3	.....	3	Twin cyl. engines	1,550	..	.....	.....	..	.....	.....	In operation
..	.....	1	140,000	2	.....	2	1 cyl. 1 turbine	6,750	1	.....	.....	2	4,000	.....	Placed in operation
..	.....	2	40,000	2	200	1	Cond. turbine	375	1	.....	.....	..	.....	.....	Placed in operation
						1		1,250							
..	.....	..	.....	..	.....	..	.....	.....	..	.....	.....	..	.....	.....	.....
2	67,000	2	125,000	3	350	..	.....	.....	..	.....	.....	..	.....	.....	Steam transmitted at 450 lb. used at 110 lb
..	.....	..	.....	..	.....	1	Cond. turbine	4,000	1	.....	1 pass.	..	.....	.....	Turbine operates 3,600 r.p.m.
1	42,000	1	75,000	1	600	1	Turbine	10,000	1	10,000	1 pass.	2	8,250	.....	Placed in operation
2	45,000	2	75,000	3	300	2	Turbine	5,000	2	10,000	2 pass.	2	4,025	Steam jet	3-500 kw. aux. turbines
2	108,000	2	200,000	3	700	1	Non-cond. turbine	2,000	1	.....	.....	..	.....	.....	Placed in operation
..	.....	..	.....	..	.....	2	Non-cond. turbine	600	..	.....	.....	..	.....	.....	.....
..	.....	..	.....	..	.....	1	Non-cond. turbine	2,500	..	.....	.....	..	.....	.....	.....
3	37,000	..	.....	2	400	..	.....	.....	..	.....	.....	..	.....	.....	Under construction
1	20,000	1	50,000	..	.....	..	.....	.....	..	.....	.....	..	.....	.....	.....
..	.....	..	.....	..	.....	..	.....	.....	..	.....	.....	..	.....	.....	.....
..	.....	..	.....	..	.....	..	.....	.....	..	.....	.....	..	.....	.....	.....
..	.....	..	.....	..	.....	..	.....	.....	..	.....	.....	..	.....	.....	.....
3	19,400	3	33,000	3	185	..	.....	.....	..	.....	.....	..	.....	.....	.....
..	.....	..	.....	..	.....	1	Engine	200	..	.....	.....	..	.....	.....	In operation
..	.....	1	132,000	..	.....	..	.....	.....	..	.....	.....	..	.....	.....	.....
..	.....	..	.....	..	.....	..	.....	.....	..	.....	.....	..	.....	.....	.....
4	16,000	..	.....	2	160	3	Engines	150	..	.....	.....	..	.....	.....	Placed in operation
	14,000							250							
								700							
..	.....	..	.....	2	10 x7x12	2	Engines	175	..	.....	.....	..	.....	.....	Placed in operation
					7½x5x10										
..	.....	..	.....	..	600	..	.....	.....	..	.....	.....	..	.....	.....	.....



The Springwells pumping station of the City of Detroit contains two 5,000-kw. units that provide energy for operating motor-driven pumps

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ing it the largest steam central station in the world. The entire May 31 number of *Power* was devoted to the engineering problems of this extension.

The completely reconstructed Lincoln Plant of the Boston Elevated Railway Co. was placed in operation. The pressure in this station has been raised from 175 lb. and 100 deg. superheat to 450 lb. pressure and 750 deg. F. The old 25,000 kw. turbine was reconditioned for the higher pressure and temperature and a new 35,000 kw. turbine was installed.

Two district heating plants were placed in operation. The boilers in both of these plants are designed for pressures of 400 lb. but are to operate at about 200 lb. The larger of the two plants is being built by the Federal government and will serve the triangle group of government buildings in Washington, D. C. This plant will contain six boilers each having a maximum steaming capacity of 237,000 lb. per hour fired by underfeed stokers. The other central heating plant serves the City of Duluth and contains four boilers having a maximum steaming capacity of 90,000 lb. an hour. They are fired with pulverized coal and equipped with air preheaters.

The past year has witnessed a greater use of hydro power in combination with steam systems. This is particularly true of the Eastern States that have available cheap coal fuel. Hydro power is no longer looked upon as a source of power competing with steam. A more complete understanding of the economies involved has shown that steam and hydro working together can produce power cheaper than either alone. There is, of course, a natural balance between hydro and steam, an economic ratio that must be determined for each system.

In large systems containing both steam and hydro it is frequently economical to increase the capacity of the hydro plants to ten or more times that required to utilize the minimum flow of the river, thus reducing the cost per unit of capacity installed. Such a plant is used to serve system peaks and for the purpose replaces steam capacity.

Hydro plants on a steam system make possible operating economies by making it unnecessary to maintain steam capacity ready to serve in case of emergency, by decreasing boiler banking losses and are of assistance in maintaining system frequency.

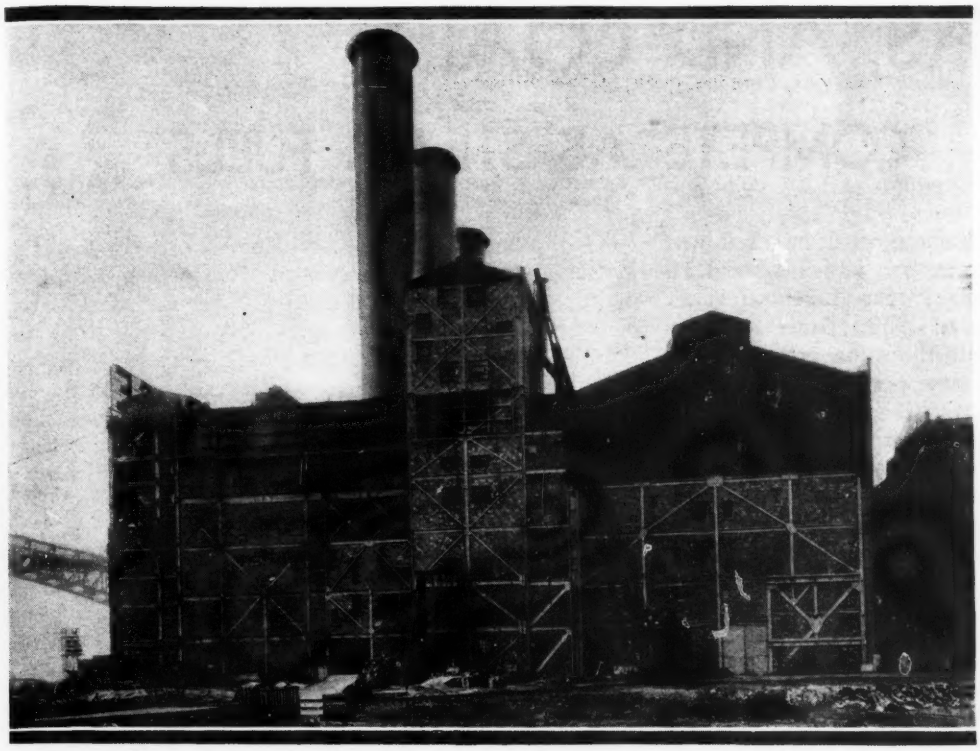
There appears to be some evidence of a trend to greater use of air preheaters. In the table showing equipment data of plants under construction or placed in operation, seventeen plants are shown to have installed air preheaters whereas only nine installed economizers. Although the majority of air preheaters are installed with pulverized coal firing, oil or gas, nevertheless two installations were made in connection with underfeed stokers.

Industrial and Municipal Power Plants

Power plant construction in industrial, institutional and municipal plants has shown greater activity than central stations. While this is not true from the point of view of the capacity installed it is true of the number of units, as evidenced by the table which shows that power equipment was installed or placed in operation in 23 industrial, 20 institutional and 8 municipal plants. Many observers predict that with the return of business there will be even greater activity in building of isolated power plants.

The table shows a marked trend toward the use of 450 lb. pressure in industrial plants. There seems to be no indication that these pressures will often be greatly exceeded, though of course 650- and 1,400-lb. industrial plants are now in operation.

In process plants the conditions are fundamentally different from those in central stations. Reheating is practically never employed. Few plants, except the very largest, find condensing operation profitable. The optimum steam pressure varies from plant to plant and is determined by the steam rate required to generate the power load as a byproduct of the process-steam load. The trend of industrial pressures in 1932 indicates that



This new addition to the Kearny station of the Public Service Electric & Gas Co. houses a 20,000-kw. mercury-vapor unit

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this balancing point is frequently also the point of best dollar economy.

Steam temperatures likewise are fixed by conditions entirely different from those in central stations, since, generally, a moderate degree of initial superheat is sufficient to give reasonably dry steam at an exhaust above atmospheric pressure. Thus very few industrial plants have any call to go to temperatures above 750 deg. and many of them find temperatures from 500 to 650 deg. entirely satisfactory even at 450 lb. pressure.

Outstanding industrial plants placed in operation during 1932 are those of the Blandin Paper Co., Jacob E. Decker & Sons and the Pennsylvania Sugar Co. The first two of these plants operate at 459 lb. pressure and 650 deg. temperature, the latter operates at 400 lb. pressure and 500 deg.

In the plant of the Blandin Paper Co. at Grand Rapids, Mich., a 90,000 lb. per hr. boiler with economizer and air preheater supplies steam to two 6,750 kw. bleeder condensing turbines. The boilers are fired by pulverized coal from a 10 ton unit mill. Air for combustion is preheated to 405 deg. and the feed water is heated to 281 deg. in the economizer at maximum rating.

At the Jacob E. Decker Plant two 60,000 lb. per hour boilers were installed and supply steam at a 375 kw. condensing unit and a 1,250 kw. bleeder unit. The boilers of this plant are also fired with pulverized coal and air is preheated to 350 deg., but economizers have not been installed.

The Pennsylvania Sugar Co. plant in Philadelphia has both economizers and air preheaters used with two 300,000 lb. per hour pulverized coal fired boilers. One non-condensing bleeder turbine of 2,000 kw. capacity was installed. The boilers and turbines were added to an older 150 lb. pressure plant and arranged to fit the process requirements. The addition of this 400 lb. equipment is reported to have saved about $200,000 a year in fuel alone.

Although no new municipal plants were placed in operation, nevertheless additions to eight plants are reported. Outstanding among these are the 25,000 kw. addition to the Pasadena municipal plant, the 15,000 kw. addition to the Richmond, Ind., municipal plant and the 5,000 kw. unit added to the municipal plant at Colorado Springs. The turbine unit added to the Richmond, Ind., station is the largest 3,600 r.p.m. condensing unit in operation.

Data in the table seems to indicate that engines and turbines are equally popular for institutional power plants, sixteen engines and eleven turbines having been installed in the plants reporting. In all but two of the plants pressures of 250 lb. or lower are in use. Among the institutional plants, those of interest are the power plant for the Ohio State Penitentiary at Columbus, Ohio, which will have a 3,000-kw. turbine operating at 450-lb. pressure and 700 deg. F. and the New York Hospital-Cornell Medical College Associates power plant which will contain three twin-cylinder, 1,550-kw. engines sets with A.C. and D.C. generators.

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Process Evaporation by Submerged Combustion

EXPERIMENTS indicate that waste sulphite liquor can be evaporated successfully by submerged combustion, that is, by an unprotected flame under the surface of the liquid. The experiments reported in a paper presented before the Association of the Pulp & Paper Industry in Portland, Ore., and reviewed in a recent number of the *Paper Trade Journal,* were carried out by Kenneth A. Kabe in the chemical engineering laboratory of the University of Washington. Unneutralized liquor, containing 12 per cent solids, was charged into the boiler. A thermal efficiency of about 90 per cent was obtained. The flame was formed by a mixture of city gas and aid delivered under the liquid surface through a tube.

OIL, GAS, AND COAL
COMPETE AS STEAM FUELS

PRODUCTION of bituminous coal has followed the decline in power generation and industrial activity; mining operations having fallen 26.1 per cent in the first eight months of 1932. Anthracite production did not suffer to quite the same extent, falling off only 23 per cent in the same period. Natural gas, however, has improved its relative position. In the face of adverse conditions, production decreased only 8 per cent. Pipe-line construction has continued almost undiminished, and natural gas is now available in 39 states. Rigid production control initiated late in 1931 appears to have improved conditions in the oil industry, although some apprehension is felt as to whether these gains will be retained. Production of crude in the first seven months of 1932 was 463,500,000 bbl., as compared with 498,600,000 bbl. in the same period of 1931.

The year has witnessed increasing competition between fuels, which has added to the other difficulties of the fuel industries. It has affected the coal market to such an extent that the Interstate Commerce Commission has given the railways authority to meet competing natural gas by reducing rates on solid fuels to the Middle West.

The availability of fuel oil and natural gas at prices competitive with solid fuels, and the desire of engineers to use the lowest priced fuel, has led to the development of combination burners that can be changed with little effort to use either coal, oil or gas. This demand for equipment that will utilize two or more fuels has been carried into stoker-fired plants, and it has been found comparatively simple to install oil or gas burners above stokers. In such installations the stoker parts are protected when operating with oil or gas.

Some plants are experimenting with the use of gas and pulverized coal simultaneously under the same boiler. Several large plants in the East have shut down pulverized-fuel equipment in favor of oil fuel. It may also be observed that most plants designed for oil firing are laid out with room for the installation of coal-burning equipment in case of an adverse change in the price of oil.

Although no orders for stokers of unusual size were placed during the past year, the average size continued to increase during 1932. Sales of stokers and pulverized-coal-fired units as reported by the Department of Commerce indicate increasing interest in stokers. This may be due to comparable efficiencies now obtainable with both firing methods.

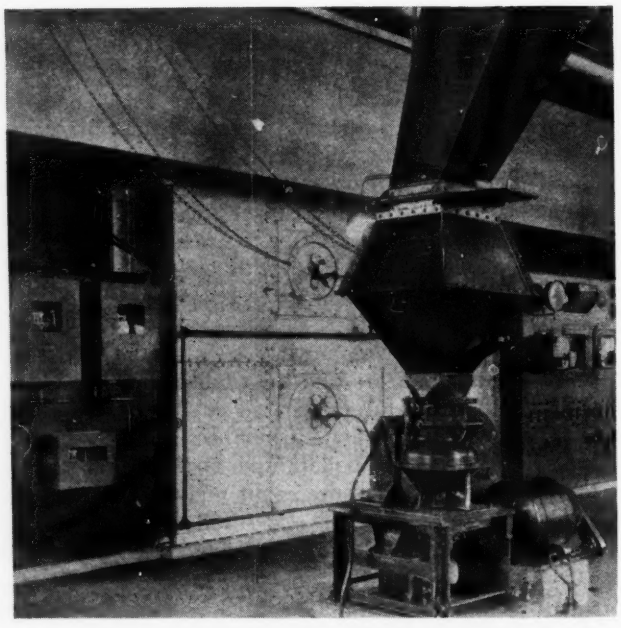
During the year the world's largest stokers were placed in operation at the Hudson Ave. station of the Brooklyn Edison Company, where eight underfeed stokers, 15 retorts wide and 69 tuyeres long, are installed. These stokers, which were described in the May 31 number of *Power*, are 26 ft. 8 in. long from the front wall of the furnace to the rear apron of the ashpit and exceed by 3 ft. the length of any previously built underfeed stoker. A feature is the size of the clinker-grinder rolls, which are 34 in. in diameter, permitting the shafts to straddle the building columns.

Operating results of stokers employing either manual or automatic zoned air control have shown that both efficiency and combustion rates may be increased by this means. At the Beacon Street heating plant of the Detroit Edison Co. a second stoker has been equipped for manual zoned air control which resulted in increasing the coal burned per square foot of grate surface from 59.2 to 77.7 lb. per hour, an increase of 31 per cent. At Delray No. 3 of the same company, automatic zoned air control and other stoker changes improved the yearly average efficiency from 82.3 to 85.4 per cent. A new installation of air control was made under an 11-retort 33-tuyere stoker at the Chester Station of the Philadelphia Electric Co. Combustion rates of 90 lb. of coal per sq.ft. per hour have been secured for long periods when using air preheated to 570 deg.

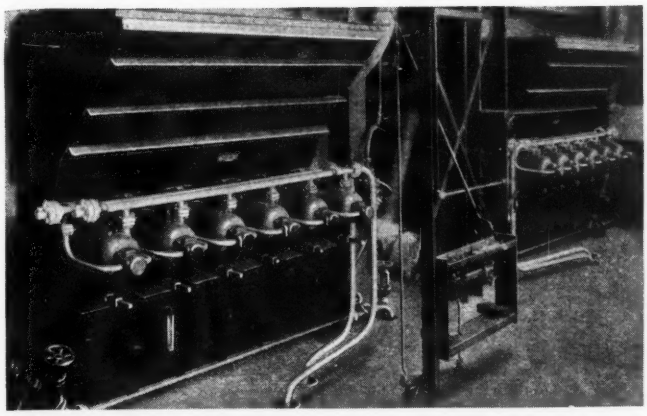
An underfeed stoker has been developed which permits continuous discharge of ash without the use of clinker grinder. A bridge wall is utilized that holds the burning fuel on the end of the stoker, but at the same time permits articulating extension grates to discharge ash continuously into the ash pit. Although air is not supplied to the ash pit and no combustion is intended to take place there, relatively low carbon loss is claimed. This design is especially applicable where head room is limited, as it requires less space than either the dump grate or clinker-grinder types.

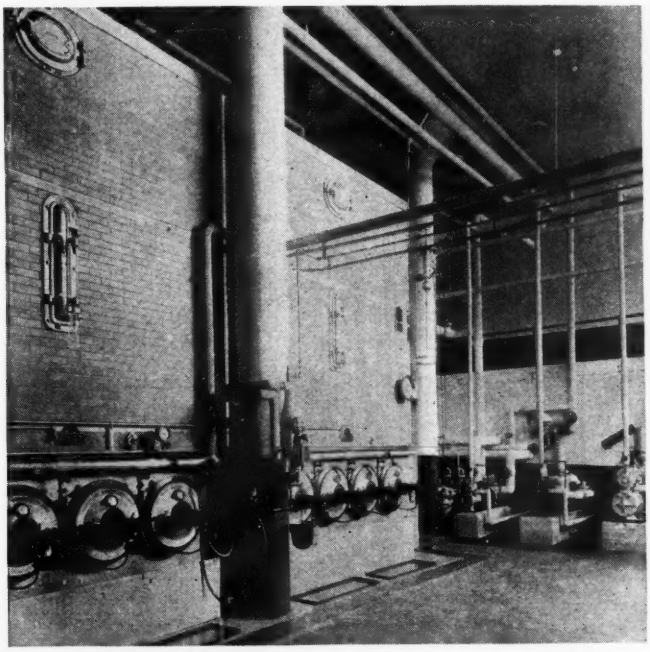
A new type of bottom-discharge cast-iron plate ash hopper with hydraulically operated clamshell gates has been developed for installations having low basement head room. These hoppers are fabricated in sections with individual gates and drip troughs and are suitable for installation on either underfeed or chain grate stokers.

The use of slag-drip side walls has been found effec-

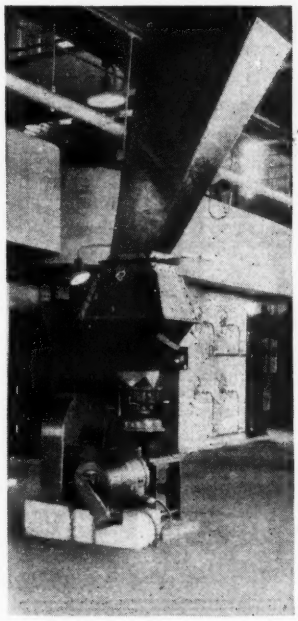


Fuel competition extends use of combination firing . . . Continued trend toward unit systems for pulverizing coal, elimination of time lag in ball mills, and continuous ash removal from underfeed stokers without clinker grinding are other high points





(Top)
Stoker installed at Iowa State University has hydraulic drive



Oil firing at Cashman Laundry is typical of many small industrial plants

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Operating floor showing coal feeders at Oxford Paper Company's new plant

tive in preventing molten slag on the walls above from running down and interfering with the operation of the last retort. An installation of slag-drip walls was recently placed in operation at Iowa State University, where 9,500-B.t.u. coal having 4 to 5½ per cent sulphur and 15 per cent ash is fired by a 29-tuyere underfeed stoker. Efficiency of over 80 per cent is reported without air preheater or economizer.

Improvements have been made to both mechanical and hydraulic stoker-drive mechanisms. The electro-hydraulic drives on the stokers at Hudson Avenue have a coal feed range of 100 to 1.

Considerable interest has been shown by European engineers in American stokers. This is evidenced by installations during 1932 in three English plants, three in France and one in Russia. All of these plants have been designed to burn various grades of European coals.

In the first nine months of last year 68 orders for unit pulverizers were reported with no reported orders for the central system. This would appear to indicate that the trend to unit systems is continuing. This, however, may be misleading in view of the fact the bin system is most generally used in large plants and that during 1932 only one large utility power plant project was initiated.

The trend in burner design has been toward larger capacities, and burners that will handle up to 100,000,000 B.t.u. per hour using coal, oil or gas are in successful operation. Improvements have been made to decrease the draft loss across both natural and forced draft burners.

The boilers of the new Buzzards Point plant of the Potomac Electric Power Co. are to be equipped with slag-tap furnaces. This is believed to be the only slag tap furnace ordered during the past year. By properly supporting the side walls, and by using air or water cooled, or accordion-type bottoms, much of the trouble encountered with this type furnace has been overcome.

Time lag between increase of coal feed and increase in the rate of combustion has been considered as one of the characteristics of ball mills. By modifying the design of the ball mill so that the mill output depends upon air flow instead of coal feed this lag characteristic has been overcome. The coal feeder is automatically regulated to maintain a constant level of fuel within the mill. This makes it possible to handle sudden changes in boiler output when this type mill is used in unit systems.

A colloidal mixture of pulverized coal is being tried out as fuel for the Cunard liner *Scythia*. About 40 lb. of coal, pulverized so that 95 per cent passes through a 200-mesh screen, is mixed with 60 lb. of heavy oil.

Combustion under several atmospheric pressures is a recent European development. Several units are under construction, and one experimental plant is in operation. Oil is burned under pressure, and the products of combustion pass at high velocity through the boiler tubes, a gas turbine, superheater and economizer before going to waste. The turbine drives a turbo-compressor that supplies air for combustion and a boiler circulating pump.

YEAR NOTABLE FOR 450-LB. INDUSTRIAL BOILERS

FEW central station boilers were installed during 1932. Interest in a review of the year therefore concentrates on the substantial number of boilers which were installed in industrial, municipal and institutional plants. The most notable fact in the industrial field was the high percentage of orders for boilers to operate in the range around 450 lb. pressure.

Some of the industrial boilers were supplied to new plants, but more were ordered for installation in existing plants to lower the unit cost of steam generation and, in many cases, to attain a better heat balance by the use of higher pressures.

In central stations no installations were completed for pressures as high as 1,400 lb. Interest in higher pressures continues, however, as shown by the support of investigations of critical-pressure series-flow units at Purdue University and at the plant of one of the large boiler manufacturers.

Space Utilization at Hudson Avenue

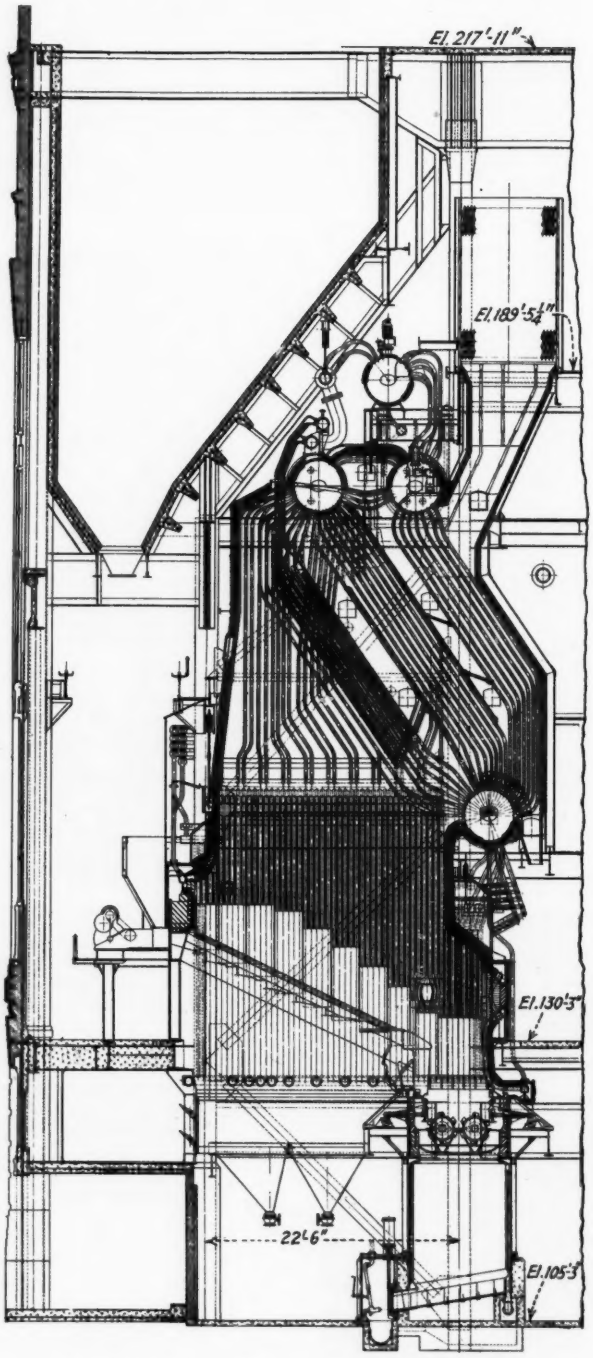
In spite of the dearth of central station construction the outstanding single boiler job of the year lay in this field. Capacity of the Hudson Avenue station, Brooklyn Edison Company, was increased by 320,000 kw. in two turbine units, making this a 770,000-kw. station, the largest steam power plant in the world. The entire May 31 number of *Power* was devoted to the engineering problems of this extension. The two new 160,000-kw. turbines are served by a total of eight boilers. Full turbine load corresponds to 500,000 lb. per hour per boiler, assuming two boilers out of service.

The power-plant building was completed some years ago, and ample space left between columns to take care of boilers as then designed for much smaller capacity. The clear space between columns, measured in the direction of furnace width, is 28 ft. 6 in. The center-to-center spacing in the perpendicular direction is 22 ft. 6 in. Within the limitations of these columns, and under the existing boiler-house roof, had to be installed a 500,000-lb. steam per hour boiler unit, including economizer. To provide the necessary heating surface (24,450 sq.ft.) and at the same time allow a furnace volume of 14,000 cu.ft., the whole design of the unit was molded to the available shape, and the stokers and furnaces were extended beyond the building column lines at the front and rear of the boiler, giving a total (underfeed) stoker area of 694 sq.ft.

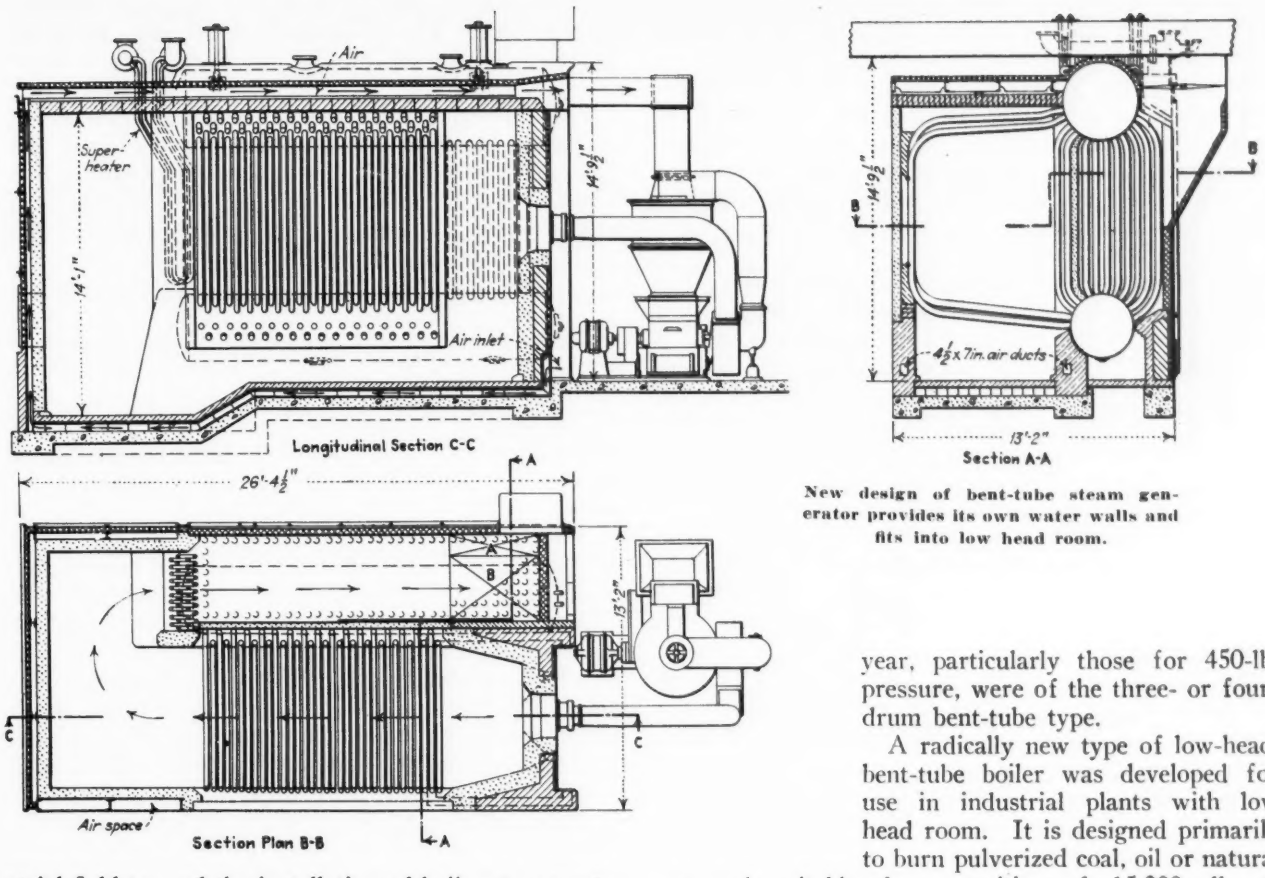
These boilers are notable not only for their extreme utilization of available space, but also for innovations in the accessories. Water columns are omitted. Only two pairs of blowoff valves are connected to the mud drum. Special arrangements permit reductions in the number of safety valves.

Industrials Show Preference for 450 Lb.

As some observers had predicted, and as has already been pointed out, there was a marked trend in the in-



At Hudson Avenue it was necessary to provide in each unit a steaming capacity of 500,000 lb. per hr. within the limitations of columns spaced (centers) 28 ft. 6 in. x 22 ft. 6 in.



New design of bent-tube steam generator provides its own water walls and fits into low head room.

dustrial field toward the installation of boilers to operate at 450 lb. or thereabouts. In the parlance of industrial plants, this, or any pressure over 300 lb., is "high pressure."

The special conditions of industrial plants frequently make pressures in the range from 300 to 600 lb. perfect from the viewpoint of heat balance so that no additional fuel can be saved by going to the central-station maximum of 1,400 lb.

An important factor in the acceptance of 450 lb. pressure for many of the new industrial boiler installations is the availability of boilers, boiler equipment, piping, valves and auxiliaries which can be operated at this pressure continuously, and with no more trouble than at pressures of 150 or 200 lb. Even more important, perhaps, is the perfection of methods of feed-water treatment and boiler water conditioning, which make possible safe, convenient and economical operation at this pressure with high percentages of make-up water containing large amounts of impurities.

Confirming this general belief is the highly satisfactory operation of such plants as the Waldorf Paper Products Co. (650 lb. pressure) and the Champion Coated Paper Co. (650 lb., 750 deg.).

Many Bent-Tube Boilers

The last-named plant has been out of operation for only two or three weeks in a period of two and one-half years, an average of one week per ten months, which is only one-half the original estimate made upon installation. In this plant, as in others that are operating satisfactorily at this pressure with high percentages of make-up, feed-water conditioning is receiving careful and continuous attention. However, the treatment is chemical, and no evaporators are used.

A large percentage of the boilers installed during the year, particularly those for 450-lb. pressure, were of the three- or four-drum bent-tube type.

A radically new type of low-head, bent-tube boiler was developed for use in industrial plants with low head room. It is designed primarily to burn pulverized coal, oil or natural gas, and suitable for capacities of 15,000 lb. to 100,000 lb. of steam per hour, and any desired pressure. The boiler is of the two-drum type, drums parallel to the depth of the furnace and on one side of it. A double row of tubes completely encircles the furnaces, thus greatly increasing the radiant heating surface. A refractory-lined pre-furnace is provided to insure ignition.

There has been little use of special alloys in the construction of boilers proper, since ordinary low-carbon steel is adequate for the pressures and temperatures now carried. In a few cases special alloys have been used for fastening of baffles, and use has been made of high-chromium steel sheets for baffles in a few places. Special alloys are finding increasing application in superheater construction for steam temperatures above 750 deg.

Water Walls

The continually increasing use of water-walls by designers of boiler furnaces is clearly indicated for stoker firing as well as pulverized coal. The water-walls are used not only in central-station boilers, but also to a large extent in most of the industrial boilers designed for operation at high ratings.

A notable development of the year in the field of water-cooled walls was the stud-tube type of construction. Studs welded to the tubes are used to hold a plastic refractory of suitable heat conductivity. A protective layer, consisting of this refractory and collected slag, tends to stabilize at a certain thickness, depending upon the furnace temperature at the point of installation. Stud tubes are used as slag screens below the regular banks of tubes, and are claimed to reduce greatly the slagging of the regular boiler tubes. They are also used in wall construction.

Both economizers and air heaters are widely employed

in the new installations, both singly and in combination. A considerable number of the 450-lb. industrial boilers use the air heater without economizers.

Fusion-welded boiler drums have received the unqualified approval of most users of modern boilers for pressures up to about 600 lb. Up to Nov. 1, 1932, one company had received orders for more than 455 welded boiler drums. This number includes welded boiler drums sold in "non-code" states before the approval of welding by the A.S.M.E. Boiler Code.

At first these drums were accepted as a cheaper, but satisfactory, substitute for riveted drums. They are now looked upon by the leading boiler manufacturers, and by most users, as actually superior types of construction, providing a greater actual factor of safety and some degree of insurance against the so-called "caustic embrittlement," as far as this might be caused by the concentration of caustic soda in riveted joints.

While the principal use of welding in boiler construction is in the fabrication of seamless drums, some smaller boilers, chiefly experimental, have been entirely welded, including the tubes and headers. One of these is designed for a pressure of 1,900 lb. per sq.in. One firm has placed on the market a welded fire-tube boiler for moderately high pressures and high ratings. It is electrically welded and stress relieved. All seams are inspected by X-ray in accordance with the A.S.M.E. Boiler Code.

A new development in welded boiler drums is the spinning down of the ends to form "self heads," thus replacing the welded head.

During the year a novel and unusual method of desuperheating steam was made public. This method, in use at the plant of the National Cash Register Co., at Dayton, Ohio, injects steam at 400 lb. and 700 deg. into the water of a boiler operating at 165 lb. pressure. Normal operation of the boiler is in no way interfered with. The combined water and high-pressure steam feed is delivered at 165 lb. pressure without superheat. The high-pressure steam enters the mud drum and is passed through distributing tubes into the lower bank of boiler tubes. There is said to be no knocking or hammering.

Superheaters and Boiler Accessories

For years designers have worked on the problem of maintaining a practically constant superheat at various ratings. In this attempt various combinations of radiant and convection superheaters have been tried out. During the year there were installed at the Trenton Channel Station of the Detroit Edison Co. two semi-radiant superheater sections in parallel, one in each side of the boiler. Each discharges its steam through convection loops, all on one side of the boiler. By adjusting the dampers on the two gas outlets in the boiler it is possible to vary the quantity of gas passing over the convection superheater to maintain a fairly constant superheat.

A new superheater for horizontal return tubular boilers was placed on the market. This consists of heavy-gage steel tubing with cast-steel headers and safety valve, all supported from the main boiler shell. The bank of superheater tubes is in the form of a half circle. It will make possible the modernization of many old return-tubular boilers.

During 1932 was reported a new feed-water regulation hookup adequate to the severe requirements of waste-heat boilers. Two thermostatic feed-water regulators are connected in series, in such a way that one is influenced by the rate of steam flow, the other by changes in boiler water level. They operate together to control the feed valve.

The difficulties in reading, controlling and measuring the water level in high-pressure boilers were more generally recognized, and various means were provided to avoid the disappearance of water from the gage glass, which sometimes occurs in high-pressure boilers when the load is suddenly dropped.

Feed-Water Conditioning

During the year very great progress in the scientific control of feed-water quality became evident. This was due not so much to radical new developments as to general adoption of the best practice already available. Wide use of high pressures and high rates of driving had uncovered many weaknesses in existing methods. It is now generally accepted that feed water, whether condensate or raw water, should be treated. Condensate may be treated in the boiler. Raw water is treated either externally or in the boiler, and sometimes both.

There are many examples of hot-process lime-and-soda softeners operating satisfactorily on 450-lb. boilers with high percentages of make-up. For pressures over 200 lb., the lime-and-soda treatment is generally supplemented with phosphate. This makes possible the complete elimination of scale-forming hardness and the maintenance of a safe sulphate-carbonate ratio without the introduction of an objectionable excess of soda ash.

Higher pressures and increased driving have necessitated better control of concentration of solids in boiler water by blowing down to prevent harmful priming and foaming, which would affect the superheater and be dangerous to engines or turbines. This situation has resulted in the wider use of continuous blowdown with heat exchangers. Sodium aluminate has found increased application as a coagulant in boiler water conditioning.

For some years experiments have been going on at the plant of the Dow Chemical Co. in the use of diphenyl oxide, diphenyl and similar substances of high-temperature process work. These substances produce a high temperature at moderate pressures. During the year announcement was made of the operation at that plant of a boiler using "Dowtherm" as the operating fluid. This is a mixture of diphenyl oxide with diphenyl and similar substances. Its thermal properties are such that it can be employed advantageously as a heat-transfer medium at temperatures of 500 to 700 deg. F., and at correspondingly low pressures ranging from zero to 100 lb. gage. The boiler employs forced circulation, and is now available for general application.

The construction of mercury boilers for process work also continues. A notable development of the year is the $4,000,000 mercury vapor steam plant nearing completion at the Schenectady works of General Electric Company. A mercury boiler and turbine "top" is also being installed in the Kearny (N. J.) plant of the Public Service Gas and Electric Company. More will be said of these installations under the heading "Mercury Plants," on page 34.

While business conditions in Europe have been even worse than in the United States, notable developments have been made there in the field of boilers. These are described under the heading "Foreign Developments," on page 35.

TURBINE

EFFICIENCIES RAISED BY DETAIL IMPROVEMENTS

Automatic program loading, instruments for recording turbine operating characteristics and increased use of welding in turbine and condenser construction are among developments and trends in turbine and condenser practice for 1932

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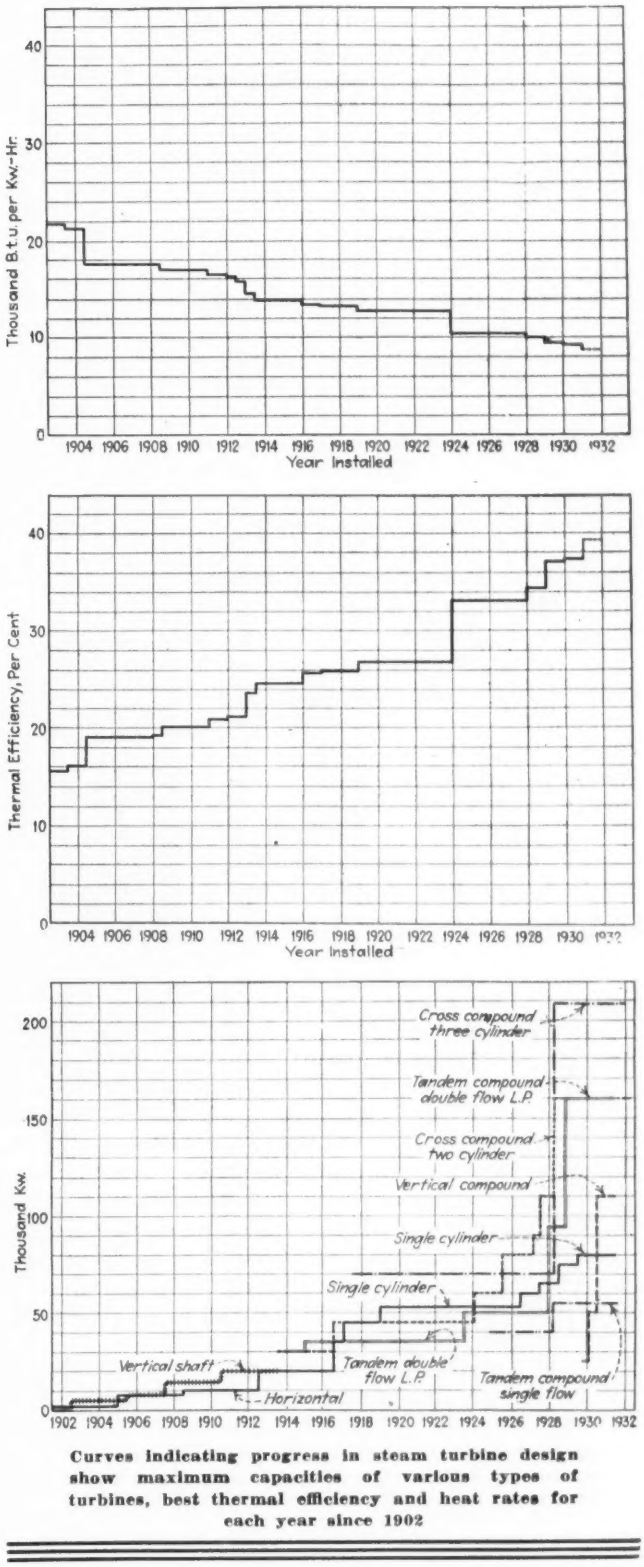
MOST electric utilities have considerably more turbine generating capacity on their systems than present demands for power require. As a result, few orders for central station turbines have been given. Only one large unit was ordered during the year—a 165,000-kw. tandem compound turbine for installation in the Richmond Station of the Philadelphia Electric Co. This unit, however, probably will not be delivered until 1934.

Several outstanding units mentioned in last year's review were placed in operation during the year. Among them are the two 160,000-kw. tandem turbines at Hudson Ave., the 75,000-kw. single-cylinder turbine at the Kearny plant of Public Service Electric & Gas Co. and the 18,000-kw., 3,600-r.p.m. unit at the Burlington station of the same company. Work on the 1,200-lb. pressure, 825-deg. tandem units of 125,000- and 150,000-kw. capacity for the State Line station of the Chicago District Electric Generating Corp. has been practically suspended because the delivery date for these units has been deferred. Construction work on the 1,290-lb. pressure, 840-deg. 80,000-kw. tandem turbine for the Port Washington plant of the Milwaukee Electric Railway & Light Co. is well under way, and shipment is scheduled for early this year.

3,600-R.P.M. Generators

Considerable interest is evidenced in 3,600-r.p.m. turbine generators. The Hawaiian Electric Co. has ordered a 10,000-kw., 3,600-r.p.m. unit. This machine will operate with steam at 650-lb. pressure and 825 deg. F. in connection with an existing plant in much the same way as the 18,000-kw. unit at Burlington. A 15,000-kw., 3,600-r.p.m., single-cylinder condensing turbine is scheduled to go into operation early this year in the municipal plant of the City of Richmond, Ind. This is the largest capacity high-speed condensing turbine. Two compound 3,600-r.p.m. units of 25,000-kw. capacity are under construction. A capacity of 35,000 kw. is at present set as the limit in size for 3,600-r.p.m. single-cylinder turbine generators.

The accompanying curves show the trend of turbine progress from 1902 to date, as regards capacity, heat rate



Curves indicating progress in steam turbine design show maximum capacities of various types of turbines, best thermal efficiency and heat rates for each year since 1902

and thermal efficiency. They are representative of both European and American practice.

The 20,000-kw. mercury turbine for Kearny has been shipped, and the unit for the General Electric Company's plant at Schenectady is scheduled to go into operation early this spring. Both these units are double flow turbines. The mercury vapor enters at the center and flows axially in both directions, thus placing both shaft seals under vacuum. By this means the possibility of mercury vapor leakage at the shaft seals is eliminated.

The lull in large turbine construction has been utilized by some manufacturers to conduct research work and make important changes in turbine design. The 35,000-kw. turbine placed in operation at the Lincoln plant of the Boston Elevated Railway incorporated design changes intended to decrease the length of the unit. The second such unit is the 75,000-kw., single-cylinder machine at Kearny. This occupies the same floor space as a 40,000-kw. machine. The changes in design have permitted shortening shaft seals, bearings and dummies. The Kearny unit contains a 37-in. blade on an 80-in. dia. drum and operates at a tip speed of 1,211 ft. per sec. The unit has straight reaction blading made possible by employing axial clearance blading in the high-pressure stages. The reversion to reaction blading only in a single-cylinder unit was indicated by the load requirements at the station. It may be mentioned that the 160,000-kw. units at Hudson Ave. have last-stage blades with an effective length of 38 in., but the tip speed is slightly less.

Turbine efficiencies have undergone considerable improvement. Rankine efficiencies of 85 per cent and over are now obtainable. A report from Sweden credits the new 50,000-kw. radial-flow turbine placed in operation this year at the Vasterås station with a Rankine cycle efficiency ratio of 90.3 per cent. This unit is the largest radial-flow turbine in operation. One of the recently installed 160,000-kw. units under feed heating operation has shown a heat rate of 10,420 B.t.u. per kw-hr. on test. The unit operates on steam at 400 lb. pressure and 730 deg. F.

The high blade speeds now used in the larger units has made it necessary to give special attention to blade material that will withstand erosion and to means for removing moisture from the steam in the low-pressure stages. Stellite welded to the entering edge of the blade has come into favor for withstanding erosion. Tests made to determine the amount of moisture removed by channels provided for this purpose in the low-pressure stages of a 160,000-kw. unit disclosed that at a load of 100,000 kw., 21,350 lb. of moisture per hour were removed from the last five stages of the 18-stage turbine. Under the best conditions and most favorable load, moisture in the exhaust is reduced by 10 to 20 per cent. In units of these high blade tip speeds the condenser tubes are protected from erosion due to moisture thrown off by the last row of blades.

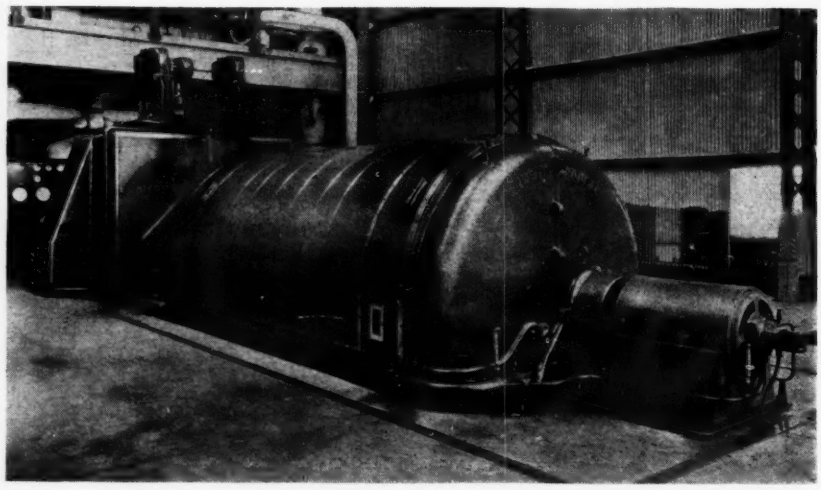
Special attention is being given to the design of turbine oil piping, and welded oil pipe is used to a greater extent than in the past. This special interest has been caused by two serious oil fires in this country and one in Belgium. Some operators are considering the practicability of removing the oil storge tank from under the turbine floor and placing it where there will be little opportunity for its igniting in case of a fire. Some consideration is being given to the separation of the governor and lubricating oil systems and also to the use of other fluids than oil for use in the governor lubrication system. Other steps being taken to eliminate oil fire hazards include removal of gage glasses from oil reservoirs and covering of steam piping with sheet metal.

Extensive work has been done to develop the underlying function of wearing strips in blading, glands and dummies. This has resulted in a new molybdenum steel having special properties for this use. This material is applied in the form of a thin narrow strip that is rolled into place. No special machining is necessary, the strips wearing quickly to give the proper clearance.

New equipment has been developed for fatigue testing of turbine blades. This new method produces a high frequency vibration of measurable amplitude and causes fatigue failure in less than a day. This has made possible a large amount of work in the investigation of fatigue failures of turbine blades.

Blade materials have not changed particularly during the past year, although extensive research is still in progress on this subject.

The use of welding in turbine construction is increasing, but in general and except where weight is an important item, it is not used for cylinder construction. Welded diaphragms for high-pressure stages with nozzle partitions of non-corrodible chrome-iron alloy are a recent development. Welding is now also being used in turbine rotor construction. One of the new stainless steels containing copper and higher silicon in turbular form is being used for lashing wire and secured to the blades by electric welding rather than the older silver soldering methods.



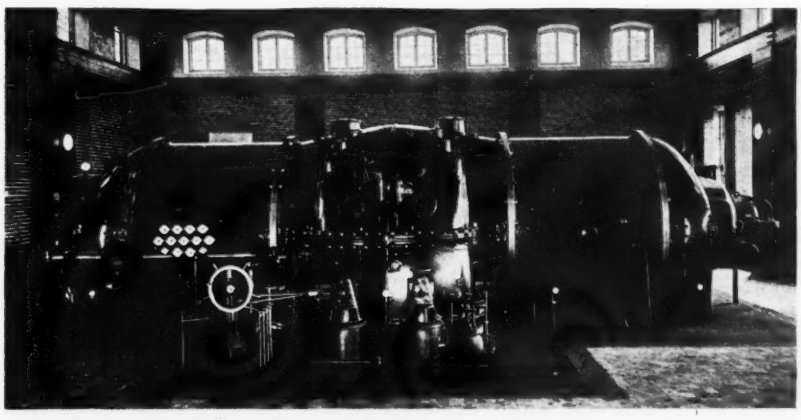
Burlington 18,000-kw., 3,600-r.p.m. turbine, operates at 650 lb. pressure and 825 deg. F.

The effort to decrease station first cost by designing outdoor generating plants has resulted in the development of instruments that record remotely the operating conditions of the turbine. Thus there are now available an eccentricity meter for measuring untruth of a turbine rotor during the critical starting-up period, a vibration recorder, a device for recording the expansion of the shaft and movement of the thrust-bearing pedestal, and

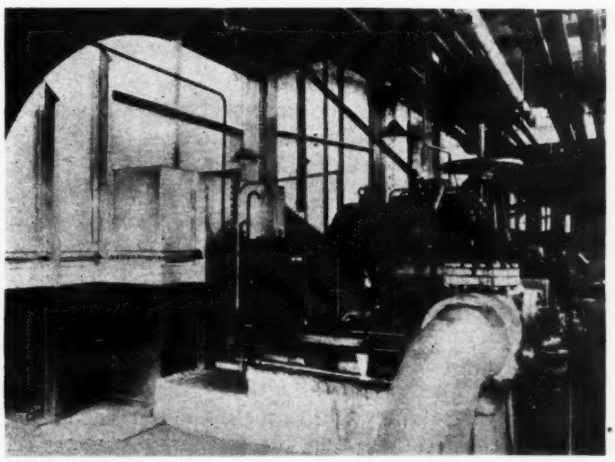
means for noting the setting of the rotor with respect to the cylinder. There is also a noise meter for listening for contact between rotating and stationary elements. These instruments have shown such possibilities and offer so many advantages for large units that they are being installed for indoor equipment.

Two systems of load control have been developed. One utilizes a Warren master frequency regulator which checks system frequency against an accurate pendulum clock, together with a unit load controller for each prime mover in the station. The latter is interconnected in such a way that each generator receives its proportional share of the station load. The position motor-type controller proportions the load between the generators as a function of valve opening, while the wattmeter-type controller proportions the load between the generators as a function of actual kilowatts. The load on the controlled units is co-ordinated with the system time error in such a manner that the system is allowed to drop one second as the units are loaded from no load to full load.

The other system controls the load on each turbine generator according to a pre-set schedule based on actual turbine performance. This automatic load control system has been in operation at the Colfax station of the Duquesne Light Co. for the past year and was described in the November number of *Power*.



Radial-flow 50,000-kw. unit at Vasterås, Sweden, has a Rankine efficiency ratio of 90.3 per cent



One of the 730-hp. auxiliary turbines driving an induced-draft fan in the Pennsylvania Sugar Co. plant. This turbine receives steam at 400 lb. pressure and exhausts at 150 lb.

▼

Additional data on the creep characteristics of metals at elevated temperatures, together with a re-interpretation of data already available, has made possible lighter construction of certain turbine parts without sacrifice of safety.

Many of the improvements and changes being made to large central station turbines are being incorporated in the design of smaller industrial turbines. There is in evidence a strong trend for industrials to install units designed for 400 to 450 lb. pressure and 700 deg. F. which in general seems to mark the limiting steam condition for industrials installing units of 7,500 kw. or less.

No unusual changes have been made in steam engine design or practice. Outstanding engines that went into operation during last year are in the power plant of the New York Hospital-Cornell Medical Associates where three units of 1550 kw. are installed. There are indications that engines are favored as prime movers for institutional plants.

During the year several outstanding condensers have gone into service. The welded shell, 65,000-sq.ft. condenser now serving the 75,000-kw. Kearny turbine is the largest welded condenser in operation and reflects the general trend to this type of construction. This unit was so large that it had to be shipped in two halves which were welded together on the job. Copper-bearing steels are now used in welded condensers to reduce corrosion. Condenser surface per kilowatt of turbine capacity has decreased to 86 sq.ft.

Two 101,000-sq.ft. condensers have been placed in operation at the Hudson Ave. station. These are the largest single-shell condensers that have been built. One of them is of unusual design. The condenser is divided into four horizontal banks on the steam side. Part of the steam exhausted from the turbine flows down the sides in bypasses to the second and third banks instead of entering the tube bank directly. This was done to relieve congestion in the top of the condenser and decrease the pressure drop. The water flow although divided into four horizontal compartments, makes a single pass through the condenser.

Manufacturers are giving special attention to waterbox design in an effort to decrease turbulence. Improvements of this nature, it is believed, will decrease tube corrosion trouble and at the same time decrease the circulating water pumping head. One manufacturer conducted flow tests on a model before completing the design of waterboxes on a large condenser.

Rolled-in tubes continue to gain in favor and appear to be playing an important part in the reduction of condenser leakage. Turbine outage on account of condensers decreased from 2.51 per cent of the period hours in 1930 to 2.16 per cent in 1931, as shown by the N.E.L.A. turbine report. This is due to a decrease in outage for condenser cleaning, probably made possible by the increased use of chlorine in the circulating water. Eleven companies are chlorinating their circulating water.

OIL AND GAS ENGINES
STRENGTHEN THEIR POSITIONS AS

A 22,500-hp. diesel and five 7,000-hp. units installed; further increases in speed and reduction of weight for given piston displacement; totally enclosed engines; increased use of alloy steels; further use of welding and greater specialization characterize year of sturdy development

LAST year the report of oil and gas engine progress pointed to the reasonable belief that with the improvement of general business conditions, the sale of these types of prime movers should rise above the 1929 maximum. To the extent that this feeling was dictated by a growing interest among power users in oil and gas engine power it was correct. In common, however, with that in other types of prime movers, the business in oil and gas engines in 1932 was less than that in 1931. But there is reason to believe that the decline, relative to other prime movers, was less.

It is not possible to arrive at definite figures this year or even statistical information as closely approximate as *Power* has previously furnished, as the source for data is no longer available. United States Government Census figures, as released Nov. 29, 1932, extend only to the close of 1931, although the data were collected during 1932.

According to the Bureau of the Census, the value of prime movers, i.e., engines, steam and oil, steam turbines, tractors, water wheels and windmills, produced in the United States during the year 1931 shows a decrease of 63½ per cent as compared with the production of the same items for the year 1929.

The horsepower of oil engines alone produced in 1931 was about 75 per cent of the total reached in 1929. As closely as may be estimated from admittedly incomplete data, about 205,000 hp. of oil engines were built in the United States in 1932, as compared with about 310,000 hp. the previous year, a decline of a little less than a third.

Meanwhile, the economic position of the diesel engine in the United States has improved considerably. It is being regarded by an increasing number of central station power companies and public utilities as a sound answer to some of their power service and distribution problems. Some public utilities are purchasing diesels for outlying districts and there is active interest in diesel engines among the smaller municipalities. Installation of oil engines is, however, still opposed by some central station power companies.

The shift to the more favorable attitude of public utilities within the past year or two is based primarily upon the decrease in installed cost per kilowatt. The over-all cost of a complete diesel generating plant of moderate capacity, including land and building, may now safely be estimated at about $85 per installed kilowatt, according to the A.S.M.E. Progress Report, as compared with $150 a few years ago. This reduction, which is greater than the general drop of price in machinery during the same period, can be explained by advances in design and construction of large diesels similar to those just described.

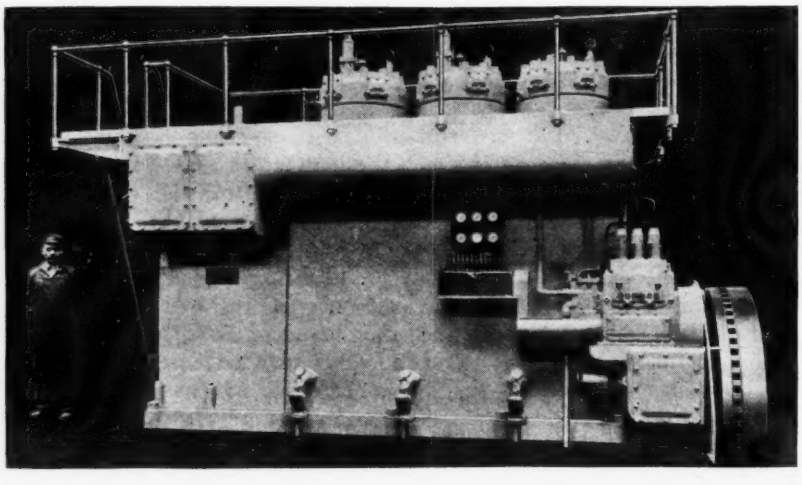
Successful and entirely practical stationary power service from diesel engines is being provided in units as small as 20 hp. Sizes, in fact, vary from self-contained farm-lighting 5-hp. sets weighing 600 lb. to the Burmeister & Wain 22,500-hp. unit for the City of Copenhagen, Denmark, which weighs 1,000 tons. One airplane diesel weighs about 3 lb. per hp.; big freight and passenger ship applications weigh 200-400 lb. per hp. Many yacht and diesel locomotive installations of high speed and light weight produce 100 to 1,000 hp., while another extreme is represented by the 26,000-hp. double-acting engines of the new German naval vessel *Bremse*, which weigh but 14 lb. per b.hp.

Active improvement in all kinds and makes, both large and small, indicates a marked consciousness of modern requirements on the part of the engine builders.

While solid fuel injection systems are being favorably received and are, to a considerable extent, replacing the air injection systems for low or high-grade fuels here and abroad, the air injection system is still favored by some manufacturers for certain fuels.

Builders continue to adapt the two-stroke cycle for isolated installations as small as 25 hp. and for units in central power plant service with engine capacities of 7,000 hp. in this country and to the maximum capacity of

A 750-hp. solid-injection Nordberg diesel of fully inclosed design



PRIME MOVERS

22,500 for the double-acting unit for Copenhagen.* Several manufacturers report that they are ready and willing to build units up to 40,000 b.hp. on the 2-cycle principle when purchasers wish.

Many of these large new engines are being installed for peak-load service as their qualifications for this service are increasingly appreciated. The Copenhagen diesel will handle peak loads, as will a recent installation of 6,000 hp. by M. A. N. at Minden, Germany. Busch-Sulzer has installed several engines of 3,000 to 4,000 hp. for public utilities for this type of service.

Two other large foreign installations of the year are those at Broken Hills, New South Wales, and at Shanghai, China. The Broken Hills plant contains six Sulzer 2-stroke, 3,000-b.hp. diesels direct-connected to 2,500-kva. generators, and four M. B. & D. 1,200-b.hp. units driving air compressors. The plant supplies power and compressed air for three local mines. The Shanghai plant, already the world's largest (36,500 hp.) is adding 13,500 hp. of Sulzer engines, to make its total 50,000 b.hp.

Probably one of the world's most efficient power plants is a diesel installation of 2,800 hp. at Luling, Texas, owned by the Magnolia Petroleum Co. It delivers a net kw.-hr. at 11,827 B.t.u. This is not a short-run record, but the average for an entire year, checked by the A.S.M.E. Diesel Power Cost Committee. The plant contains seven Worthington 6-cyl., vertical air-injection diesels direct-connected to 450-kva. generators. The running plant capacity factor (plant output divided by total rating of units) is 99.9 per cent, while the plant service factor (per cent engines operate at full load in terms of possible output) is 98.9. Thus the average overload is 99.9 + 98.9 = 101 per cent. Time lost in inspection and adjustments averages 101 hours per engine per year. Production is 12.39 kw.-hr. per gallon of oil, and total production cost per kw.-hr. is 5.86 mills.

Opinion continues to differ among manufacturers as to the advisability of high piston speeds, particularly for the large, continuous-duty stationary engines. Among the small engines used in marine service, a 4-cyl. unit of 20 hp. has a piston speed of 2,000 ft. per min., and this same piston speed is also used in 60-hp. units. The eight 2-cycle engines of the German naval vessel *Bremse* run at 600 r.p.m. Speeds up to 3,000 r.p.m. are being used by aircraft diesels, and these may soon be raised to 4,000 or even 4,500 to compete with the gasoline engine.

The United States Navy has recently tested a M. A. N. engine of 2,200 hp., similar to the engines of the German cruiser *Leipzig*. This unit, intended for submarine service, runs from 200 to 550 r.p.m. At the latter speed, the pistons travel 1,600 ft. per min. This engine, complete with auxiliaries, weighs about 17 lb. per b.hp. Development of higher piston speeds is to a considerable extent dependent upon the success of the new diesel fuels. Doped, anti-knock fuels for high-speed service will soon be put on a commercial basis.

The 3,000-hp. Busch-Sulzer installation in the Sterling Colo., plant of the Public Service Co. of Colo., running at 240 r.p.m. and the 4-unit Fairbanks-Morse plant totalling 2,760 hp. for Commander Milling Co., Minneapolis, running at 277 r.p.m., are examples of other higher-speed units. Another factor which has aided the understanding of diesel economy has been the increase of available reliable information on operating costs. A table showing results of the first six months of operation of the Commander Milling plant (which went into service Jan. 2, 1932) is appended, as is one showing operations for the same period at Tennant & Hoyt. Both are Fairbanks-Morse installations.

The interest in fuels for the modern high-speed engine is growing steadily. A previously unknown fuel characteristic, "ignitibility" has been found to determine the suitability of diesel fuels. Oil which ignites readily, after a short ignition lag, is desirable. Committees of the A.S.M.E., A.S.T.M. and S.A.E. are revising engine fuel specifications to include "ignitibility."

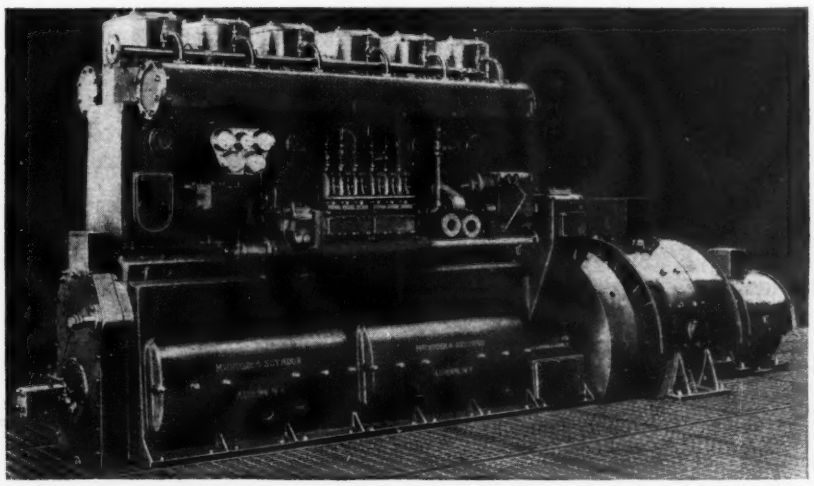
Not only in the high-speed diesel does fuel cost play an important part. In this country present figures show a differential of over 100 per cent in price between boiler fuel oil and diesel fuel in favor of the former. Some builders are already using boiler oil as a direct engine fuel.

Cracked residua, or Bunker C oil, blended with 20 to 30 per cent cycle stock and stabilized is claimed to produce a satisfactory diesel fuel for lower-speed engines running at loads averaging above 50 per cent of capacity. It is said to produce a diesel fuel from Bunker C at a cost midway between Bunker C and usual diesel fuel.

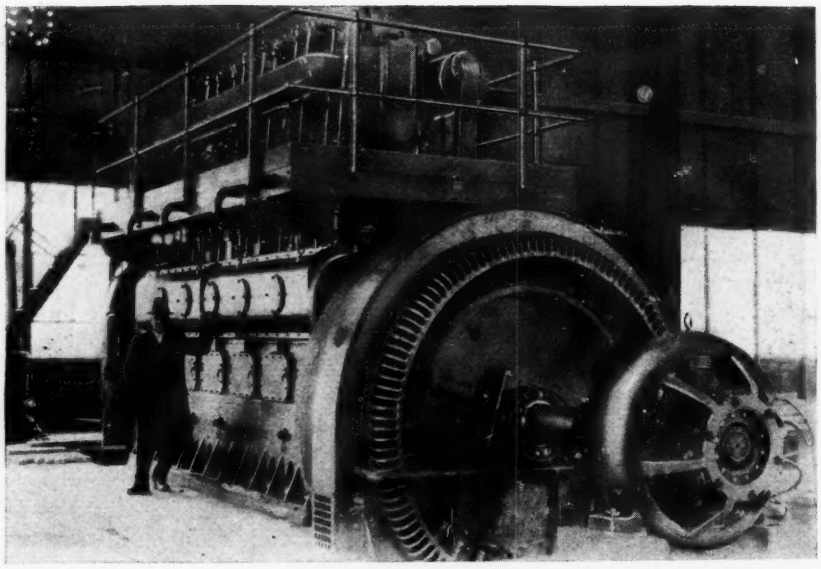
Supercharging and exhaust gas utilization are also aiding in improving diesel fuel burning, the latter both to heat incoming air and for use in waste-heat boilers. Favorable fuel economies are being reported. For example, the engines for the new Diesel motorship *Berganger* are to use 0.35 lb. of oil per b.hp., while the German cruiser *Deutschland* burns 0.385 lb. per b.hp., including scavenging. The new Copenhagen diesel is expected to burn 0.53 lb. per kw.-hr. at 12,500 kw. Use of "doped" fuels is expected to result in even further economies.

**Power*, October, 1932.

A 450-hp., 360-r.p.m. totally inclosed McIntosh & Seymour diesel with water, fuel and lubricating oil pumps integral



An unusual development of the effort to improve the 2-cycle diesel difficulties with the splash lubricating system has been overcome in Germany by installing a special lubricating pump on the crosshead-type engine or by installing a separate lubricating oil pump on each cylinder. Such designs of course increase cost—in fact to an extent where small 4-cycle units can compete successfully with the improved 2-cycle units on a price basis. Since under present economic conditions the effort has been to get as cheap an engine as possible; this means that German farmers and others needing small cheap engines are forced to purchase hot-bulb engines because they are the only remaining cheap engines. Some steps toward correcting the trouble have been taken, among them introduction of a rotating-blower splash system.



1,200-hp., 6-cyl., 4-cycle gas engine operated on sweet natural gas at the plant of Lamoka Power Corp.

An unusual foreign engine-compressor combination is the Pescara 2-cycle engine. No cranks are used, the two opposed pistons having larger compression pistons on their outer ends and operating outward simultaneously from a central combustion space. Part of the compressed air is used to scavenge the cylinder, the remainder being forced into the receiver.

The year's standard oil engine designs are notable in many ways. It becomes increasingly evident that the characteristics of present-day special alloys are being taken advantage of in order to reduce maintenance and general operating costs. Details of design show an increased consciousness on the part of builders of the desirability of low operating and maintenance expenses and reliability of units in continuous service.

The field of the oil engine is so diversified and includes so many types that each progresses more or less along its own line. Torsional vibration dampers of the hydraulic type are being used more extensively. Superchargers are under considerable discussion, with views in fair agreement that the system is not economically logical when applied to engine units of sizes small enough to permit of obtaining the increased capacity by simply changing cylinder dimensions. On the other hand, with larger units in which an increase of capacity is not so easily secured by the simple expedient of increasing cylinder sizes, superchargers have a distinct economic value. This also applies to cases where engines are installed at high altitudes. In this class of service superchargers are distinctly helpful in the production of power at low cost. While in large diesels the direct injection and undivided combustion chamber is sovereign, in automotive engines there is decided rivalry between the various systems. The two-chamber system seems now to be ahead of its rival. The open combustion chamber seems to hold its best in opposed-piston engines of the Junkers type and its various modifications, such as the German Michel engine which has a common combustion space for the Y-shaped cylinder and was subjected to successful tests recently (Story in *Power* shortly). Another opposed-piston engine is the Michell, developed in this country and distinctly different from the German Michel of almost the same name. The American Michell was described and is crankless, cam-driven unit.

The assembly of certain engine parts by welding together steel plates and structural shapes, such as in bedplate and possibly engine frame construction, is an outstanding development of the past year or so. Results obtained in the way of weight reduction have been very encouraging—witness the 14-lb. per b.hp. engines of the German naval vessel *Bremse*. Both M. A. N. and Sulzer, pioneers in this method of construction, are developing engines of 2,000 b.hp. per cylinder at 265 r.p.m. and weighing around 22 lb. per b.hp. This is about a tenth of the weight heretofore considered normal.

Another development approved by commercial practice is the "hydrogen brazing" of engine parts, primarily cylinder heads by the German A. E. G. Instead of a single casting, the head consists of a number of separate forgings which are united in an electric furnace containing hydrogen atmosphere.

Further work has been done by various manufacturers toward total enclosures of their units, and two types are illustrated. This has been greeted as a definite forward step in "cleaning up" the diesel engine.

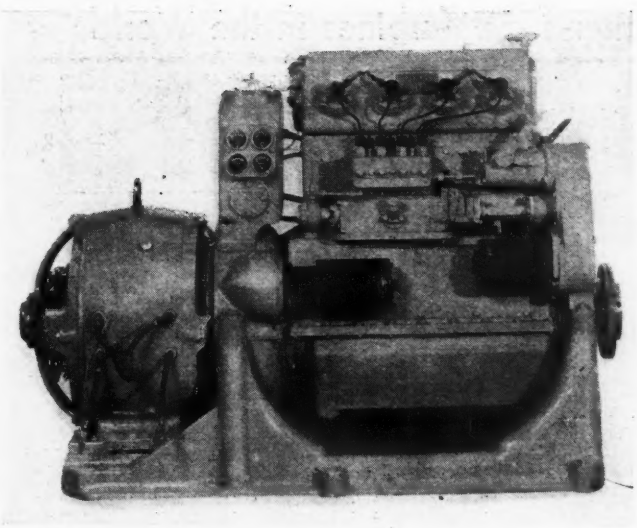
Growing appreciation of the adaptability of diesel units to industrial or isolated power generating requirements is seen in the automatic diesel installation put into operation in December, 1932, in the Number One Park Avenue Bldg., New York City. The installation consists of four 270-hp., 360-r.p.m. solid-injection engines made by Chicago Pneumatic Tool Co. All are direct-connected to Elliott generators and arranged for automatic control by the Strong system. This installation, pictured on page 38 of this number, is being watched with decided interest, particularly as it represents some pioneering steps in connection with full-automatic operation.

That the oil engine also has a place as an auxiliary in steam power plants is well demonstrated by economies reported in such cases as that of the 3,000-hp. Busch-Sulzer diesel engine installation at the Union Stock Yards, Chicago.*

The five 7,000-hp. Hamilton-M. A. N. engines built for the City of Vernon, Calif. (see page 38 of this number), by Hooven, Owens Rentschler are all shipped and in process of installation.

The transportation field is being entered actively by

**Power*, November, 1932.



A 4-cyl., 40-hp. Hill diesel direct-connected to a 10-kw. generator. This unit, designed to fit a limited space, develops 20 hp. at 1,000 r.p.m. and 40 hp. at 2;000 r.p.m. Its weight, attained by aluminum alloys, is 750 lb., and with generator 1,500 lb.—about 19 lb. per hp.

diesel engines. Diesels for automotive service are gaining in popularity both here and abroad. Germany has 3,500 automotive diesels in use, and at least four American makes of trucks are offered with diesel drive. Fuel cost savings as high as 70 to 80 per cent and better acceleration and flexibility of the diesel-driven truck are claimed by manufacturers. Some studies on fumes from motor vehicles, particularly from those fitted with heavy-oil engines, have been made in England. They show the effect of fumes to be minor, but possible causes of air pollution in congested traffic areas.

M. A. N. is constructing a 1,000-hp. engine for a zeppelin, a 7-cyl., supercharged double-acting, 2-cycle unit almost entirely of welded steel with through anchor bolts similar to the design of that company's welded battleship engines. This engine is reported to develop a peak output of 1,200 hp. at 1,000 r.p.m. and to weigh below 4.4 lb. per hp.

Diesel power for locomotives and railway services is growing in importance daily, particularly for rail cars and switching service in cities where smoke ordinances are in force. At present power is transmitted to the driving wheels by electricity in most cases, but direct drive from engine to wheels is being developed.

Probably one of the most significant developments is in the increased use of diesels in marine service. According to "British Motorship," motorships built in 1931 by thirteen countries totalled 176, with Great Britain, a center for cheap, high-grade steaming coal, leading with 52, having an indicated horsepower of 276,150 and a gross tonnage of 396,860. Holland follows with about one-third this number, and Germany comes next. The United States lists three motorships in the same period, with France, China, and Norway the only countries below it, each being credited with one ship. The United States, in fact, built only 1.2 per cent in point of tonnage during 1931.

The adaptation of diesel engines to operation with natural or manufactured gas as a fuel has taken a distinct forward step during the past year. This is particularly true in regions where natural gas pipelines have made this fuel available at usable prices. Several of the diesel engine companies have found it advisable to make their units convertible from oil to natural gas fuels and have benefitted commercially in consequence. Two-cycle gas engines have been reintroduced with much improved fuel economy. M. A. N. is applying its reverse-scavenging principle to the gas engine for the purpose of obtaining 4-cycle economy with much reduced first cost. Clark Bros. Co. has developed the 2-cycle "injection gas engine," in which the gas is introduced by a pump after the exhaust ports are covered by the piston, and thermal efficiencies claimed to exceed those of 4-cycle engines are obtained. At least two manufactured gas producers have installed gas-engine driven gas compressors for their own service and are planning to put in additional units.

Unique in that gas-engine-driven electric generators operate on gas taken from the ground near the hydro plant, the Lamoka combination gas engine and hydro-electric plant is being completed on Lake Keuka in New York State (see page 18). A vertical, 1,200-hp., 6-cyl., 4-cycle, Ingersoll-Rand gas engine direct-connected to an 800-kw., G.E., a.c. generator has been installed. A second unit is planned later. Three additional 1,800-hp. units to drive 1,250-kw. generators are now being completed by Worthington. This will give a total of 7,800 hp. During off-peak periods, the gas-engine driven generators will supply power to pump water into the hydro plant reservoir. When peak-load comes on, the gas engine and hydro plants will operate in parallel to supply the demand. This is believed to be the only generating station in which natural gas and hydro power from the same land are used in combination. The unit illustrated is the largest vertical gas engine in operation in this country.

In the field of gasoline engine construction the year has made notable contributions to stationary design. Self-contained carburetor-type units of large size, presenting distinct economies for certain classes of isolated power service, have come into the market to fill a distinct need. Experimentation with solid injection of gasoline is going ahead.

Power wishes to acknowledge its appreciation of the information furnished by the many engine builders of the United States and Europe, from which this report was largely compiled.

OPERATION REPORT OF TWO 350-HP. DIESEL ENGINES
TENNANT & HOYT POWER PLANT, LAKE CITY, MINN.
First Six Months Operation, April 1 — Oct. 1, 1932

Month	Fuel and Lub. Oil	Labor	Taxes and Insurance	Maintenance and Supplies	Total Diesel Cost Including Fixed Charges
April.....	$854.11	$75.00	$100.92	.....	$1,030.03
May.....	742.14	75.00	100.92	$283.86	1,201.92
June.....	816.71	75.00	100.92	34.17	1,026.80
July.....	842.46	75.00	100.92	6.28	1,024.66
August...	984.30	75.00	100.92	.68	1,160.90
Sept.....	863.40	75.00	100.92	64.92	1,104.24
	$5,103.12	$450.00	$605.52	$389.91	$6,548.55

Total K.W.H. Consumed..... 1,239,870
Average Demand..... 373
Cost per K.W.H. Diesel Engine, including fixed charges.....529c per K.W.H.

OPERATION REPORT OF 2,760-HP. DIESEL PLANT IN COMMANDER FLOUR MILL, MINNEAPOLIS, MINN.
Covering Six-Month Period of Feb. 1, to Aug. 1, 1932

Month	Fuel and Lub. Oil	Labor	Taxes and Insurance	Maintenance Reserve	Supplies	Tota Diesel Cost Including Fixed Charges
February...	$1,524.66	$742.49	$286.00	$200.00	$6.57	$2,759.72
March.....	1,700.57	807.35	286.00	200.00	32.14	3,026.06
April.....	1,515.10	501.30	286.00	200.00	44.65	2,547.05
May.....	1,921.65	425.17	286.00	200.00	45.46	2,878.28
June.....	1,648.86	469.82	286.00	200.00	28.99	2,633.67
July.....	1,412.10	352.37	286.00	200.00	3.25	2,253.72
	$9,722.94	$3,298.50	$1,716.00	$1,200.00	$161.06	$16,098.50

Total K.W.H. Consumed.....2,512,030 K.W.H.
Average Demand.....859 K.V.A.

Comparison of Outstanding Propeller-Type Turbines in the World

Name of Plant	Where Installed	[1]Turbine Mftr.	Number of Units	Rating, Hp.	Effective Head, Ft.	Hp. Under 1-Ft. Head	Discharge, Sec.-Ft.	[2]Type of Runner	Runner Dia., In.	Hub Dia., In.	Runner Wt., Tons	Speed, R.P.M.	Specific Speed, Eng. Units	Number of Blades	[3]Blade Material	[4]Blades Finish	[5]Draft-Tube Type	Runner C.L. Relative to T.W.L., Ft
UNITED STATES																		
Safe Harbor	Penn.	M.S.	3	42,500	55	105	8,000	K.	220	86.5	.....	109.1	151	5	C.S.	C.G.M.	E.	— 6.91
Safe Harbor	Penn.	I.P.M.	3	42,500	55	105	8,000	K.	220	86.5	.....	109.1	151	5	C.S.	C. & G.	E.	— 6.91
Rock Island	Wash.	A.C.	4	21,000	32	116	7,150	M.A.R.	223	.....	.....	100	190	6	.....	.....	E.	.....
Louisville	Ky.	A.C.	8	13,500	37	60	4,000	F.B.	.....	.....	.....	100	127	6	.....	.....	H.	.....
Black Eagle	Mont.	M.S.	3	9,300	50	26.3	1,860	F.B.	127	.....	.....	180	131	4	C.S.	C.&G.	E.	+ 7
Lewiston	Idaho	M.S.	1	7,000	35	33.8	2,075	F.B.	141	.....	.....	138.5	136	4	C.S.	C.&G.	E.	+ 7.5
Crisp. County	Ga.	N.N.	1	6,000	30	36.5	2,050	F.B.	148	46.7	11.33	100	111	4	C.S.	C.&G.	E.	+ 9.5
Holyoke No. 8	Mass.	J.L.	1	6,000	30	36.5	2,050	F.B.	.....	.....	.....	128	140	..	C.S.	C.&G.	E.	.....
Norfolk	N.Y.	M.S.	1	5,700	39.6	23.2	1,510	F.B.	127	.....	.....	164	125	4	C.S.	C.&G.	E.	+ 7
Beebe Island	N.Y.	I.P.M.	1	5,700	30	34.7	1,900	K.	118	47	.....	150	148	5	C.S.	C.&G.	E.	+ 3.7
Beebe Island	N.Y.	I.P.M.	1	5,000	30	31	1,660	F.B.	118	40	.....	150	139	6	C.S.	C.&G.	E.	+ 3.7
McIndoes	N.H.	M.S.	2	5,125	29	32.8	1,955	K.	120	.....	.....	150	159	4	C.S.	C.&G.	E.	+ 6
McIndoes	N.H.	M.S.	2	3,800	29	24.3	1,435	F.B.	120	.....	.....	150	137.4	4	C.S.	C.&G.	E.	+ 6
Chippewa Falls	Wisc.	A.C.	6	5,000	30	31	1,860	M.A.	120	.....	.....	138.5	142	4	.....	.....	H.	+ 4
Maribondo	Brazil	I.P.M.	2	5,000	59	110	840	F.B.	87	25	.....	250	108	6	C.S.	C.&G.	M.	+ 0.5
Jackson's Bluff	Fla.	N.N.	2	4,800	32	26.5	1,450	F.B.	124	39	7.35	150	136	4	C.S.	C.&G.	E.	+11
Merced Falls	Calif.	M.S.	1	4,750	26	35.8	2,200	K.	127	.....	.....	128.6	151	4	C.S.	C.&G.	E.	+ 5
Garvin Falls	N.H.	A.C.	1	4,700	30	28.6	1,720	F.B.	.....	.....	.....	138.5	135	..	.....	.....	.....	.....
Garvin Falls	N.H.	A.C.	1	3,500	30	21.3	1,280	F.B.	.....	.....	.....	150	126	..	.....	.....	.....	.....
Prosser	Wash.	N.N.	1	4,200	40	16.6	1,040	F.B.	98	33	4.27	200	129	4	C.S.	C.&G.	E.	+ 4.5
Nacooche	Ga.	M.S.	2	4,000	58	9.06	716	F.B.	72	.....	.....	400	158	4	C.S.	C.&G.	E.	+ 5.7
Dolby	Me.	I.P.M.	1	3,900	49	11.4	790	F.B.	87	25	.....	240	118	6	C.S.	C.&G.	M.	+ 4.75
Chalk Hill	Wisc.	A.C.	3	3,750	28	25.3	1,470	M.A.	.....	.....	.....	150	143	..	.....	.....	.....	.....
Guadalupe[a]	Texas	M.S.	3	3,320	29	21.2	1,140	K.	97	.....	.....	180	154	4	C.S.	C.&G.	E.	+ 5
Green Island	N.Y.	A.C.	4	3,000	13	42.6	1,700	F.B.	156	.....	8.5	80	152	4	C.S.	.....	H.	+ 8
York Haven	Penn.	M.S.	3	2,175	23	19.7	1,108	K.	93	.....	.....	200	185	4	C.S.	C.&G.	E.	+ 6
Rock River	Ill.	I.P.M.	5	800	7	43.2	1,100	F.B.	125	35	.....	80	199	6	C.S.	C.&G.	M.	+ 3.1
CANADA																		
Seven Sisters	Manitoba	D.E.W.	1	37,500	66	70	5,700	F.B.	195	67	27.5	138.5	143	6	C.S.	C.&G.	M.	— 5.6
Seven Sisters	Manitoba	C.A.C.	1	37,500	66	70	5,700	F.B.	.....	.....	.....	138.5	143	..	.....	.....	.....	.....
Seven Sisters	Manitoba	M.S.I.	1	37,500	66	70	5,700	F.B.	200	.....	.....	138.5	143	4	C.S.	C.&G.	E.	— 2.35
La Gabelle	Quebec	D.E.W.	1	32,000	60	69	5,400	F.B.	195	67	27.5	120	128.5	6	C.S.	C.&G.	M.	— 5.7
La Gabelle	Quebec	D.E.W.	4	30,000	60	64.7	5,000	F.B.	189.5	54	31.9	120	124.5	6	C.S.	C.&G.	M.	— 4.9
Great Falls	Manitoba	D.E.W.	2	28,000	56	66.8	5,000	F.B.	189.5	53.25	30.25	138.5	151	6	C.S.	C.&G.	M.	— 2.75
Great Falls	Manitoba	M.S.I.	1	28,000	56	66.8	5,000	F.B.	200	.....	.....	138.5	151	4	C.S.	C.&G.	E.	+ 1.45
Great Falls	Manitoba	D.E.W.	3	28,000	56	66.8	5,000	F.B.	189.5	57.5	25.25	138.5	151	6	C.S.	C.&G.	M.	— 2.75
Chats Falls	Que. and Ont.	D.E.W.	8	28,000	53	72.4	5,300	F.B.	195	67	2.75	125	146	6	C.S.	C.&G.	E.	— 1.6
Island Falls	Saskatchewan	D.E.W.	3	14,000	56	33.3	2,500	F.B.	139	42.25	9.75	163.6	126.5	6	C.S.	C.&G.	M.	— 1.9
Slave Falls	Manitoba	D.E.W.	2	12,000	30	73	4,000	F.B.	187	70.50	22	94.7	147.5	6	C.S.	C.&G.	M.	+ 3.8
Back River	Quebec	C.A.C.	3	[b]8,800	26	66.4	3,400	M.A.	.....	.....	.....	85.7	137	4	.....	.....	.....	.....
Back River	Quebec	D.E.W.	3	[b]8,800	26	66.4	3,400	M.A.	185	67.75	25.5	85.7	137	6	C.S.	C.&G.	M.	+ 3.44
Drummondville	Quebec	D.E.W.	2	6,000	30	36.5	2,000	F.B.	133	40.5	8.8	138.5	152	6	C.S.	C.&G.	M.	+ 3.43
Ear Falls	Ontario	D.E.W.	1	5,000	36	.....	.....	F.B.	.....	.....	.....	180	.....	..	C.S.	C.&G.	.....	.....
St. Albans	Quebec	D.E.W.	1	4,000	64	7.8	620	M.A.	75	27.5	3.2	360	125.5	6	C.S.	C.&G.	C.	+14.3
EUROPE																		
Ryburg	Ger. and Switz.	A.d.C.	1	42,000	37.7	170	10,600	K.	269	118	105	75	155.5	5	C.S.	M.A.O.	E.B.	+ 1.5
Ryburg		E.W.	1	38,700	37.7	167	10,420	K.	276	118	115	75	157	5	C.S.	M.A.O.	E.B.	+ 1.3
Ryburg		J.M.V.	2	38,200	37.7	165	10,300	K.	276	.....	116	75	157	..	S.C.S.	M.A.O.	E.B.	.....
Swir	Russia	V.K.	3	37,500	36.1	172.5	10,240	K.	292	.....	150	75	164	4	S.S.	.....	E.	.....
Swir	Russia	V.K.M.	1	37,500	36.1	172.5	10,240	K.	292	.....	150	75	164	4	S.S.	.....	E.	.....
Kembs	France	A.d.C.	5	36,600	54	92.2	6,600	K.F.	221	98.4	52	93.7	122	6	C.S.	M.A.O.	E.B.	+4.25
Dogern	Ger. and Switz.	E.W.	3	35,500	35.1	170	10,600	K.	276	.....	115	75	166	5	C.S.	M.A.O.	E.B.	.....
Shannon	Ireland	J.M.V.	1	33,000	106[c]	30.2	3,040	K.	161	.....	32	167	89	..	S.S.	M.A.O.	E.B.	.....
Klingnau	Switzerland	J.M.V.	1	19,000	26.9	136	7,620	K.	262	.....	88	75	169	..	C.S.	M.A.O.	E.B.	.....
Klingnau	Switzerland	E.W.	2	18,400	23.5	162	8,160	K.	254	.....	90	75	168	4	C.S.	M.A.O.	E.	.....
Groenvollfoss	Norway	J.M.V.	2	18,200	74.5	28.3	2,670	K.	133	.....	14	214	132	..	S.C.S.	M.A.O.	E.B.	.....
Semo Awtschali	Russia	V.K.	1	17,000	66[d]	31.7	2,550	K.	146	.....	30	167	116	4	S.S.	.....	K.	.....
Laholm	Sweden	V.K.	1	16,000	28	109	5,860	K.	216	.....	70	83.3	165	4	S.S.	.....	K.	.....
Abborrforsen	Finland	V.K.T.	2	16,000	36	75	4,520	K.	180	.....	35	107	156	4	S.S.	.....	K.	.....
Vargon	Sweden	V.K.	1	15,200	14	287	11,090	K.	315	.....	150	46.9	212	4	S.S.	.....	K.	.....
Vargon	Sweden	V.K.N.	1	14,800	14	279	10,770	K.	315	106	150	46.9	209	4	S.S.	C.&G.	K.	.....
Munkfors	Sweden	V.K.	2	15,000	51[e]	41.5	3,130	K.	146	.....	30	167	152	4	S.S.	.....	K.	.....
Pizancon	France	A.d.C.	2	14,000	33	74.5	4,250	K.	187	7.5	40	93.7	141	6	C.S.	M.A.O.	E.	+ 6.8
Lanforsen	Sweden	V.K.	3	13,000	30.4	78	4,310	K.	188	.....	35	94	152	4	S.S.	.....	K.	.....
Mixnitz	Austria	J.M.V.	2	12,000	64.5	23.2	1,960	K.	121	.....	10.5	214	120	..	S.C.S.	M.A.O.	E.B.	.....
Isar	Germany	E.W.	3	12,000	39.4	49	3,155	K.	157	.....	27	167	168	5	C.S.	M.A.O.	E.B.	.....
Cize Bolozon	France	J.M.V.	2	11,350	57.4	26	2,052	F.B.	121	.....	9.5	187	176	..	C.S.	M.A.O.	E.B.	.....
Lilla Edet	Sweden	V.K.	1	11,200	21.3	114	5,155	K.	228	.....	62.5	62.5	144	4	C.S.	.....	E.	.....
Lilla Edet	Sweden	A.B.F.	2	11,200	21.3	114	5,155	L.	236	.....	50	62.5	144	6	C.S.	C.&G.	E.	+10
Wettingen	Switzerland	E.W.	3	10,700	76	16.1	1,415	K.	114	.....	9	214	98	6	S.S.	M.A.O.	E.B.	.....
Cize Bolozon	France	A.d.C.	1	10,000	53.5	25.6	1,890	K.	118	60	11.5	187	130	6	C.S.	M.A.O.	E.	+ 2.75
Kachlet	Germany	E.W.	3	9,500	30	58	3,280	F.B.	184	.....	75	105	.....	..	.....	.....	.....	.....
Kachlet	Germany	J.M.V.	5	9,350	29.6	58	3,280	F.B.	184	.....	24	75	105	..	C.S.	C.&G.	E.B.	.....
Forshuvudforsen	Sweden	A.B.F.	2	10,200	34	52	3,160	L.	163	.....	24	94	119	6	C.S.	C.&G.	E.	+14
Baldeney	Germany	J.M.V.	1	6,460	26.6	47	2,560	K.	144	.....	16.5	125	166	..	C.S.	M.A.O.	E.B.	.....
Mori	Italy	R.S.	1	6,000	33	32	2,100	K.	126	48	12	150	150	4	C.S.	U.F.	K.	+ 7
Vallieres	France	A.d.C.	1	6,000	59	13.3	1,025	K.	86	46	5	214	102	6	C.S.	M.A.O.	E.	+ 7.3
Jonage	France	A.d.C.	1	6,000	42.6	21.6	1,460	K.	101	46	4.2	214	152	6	C.S.	M.A.O.	E.	+ 5.8
Myllykoski	Finland	V.K.T.	1	5,500	19	66.5	2,825	K.	161	.....	25	94	175	4	S.S.	.....	K.	.....
Garigliano	Italy	R.S.	3	4,420	35	21.5	1,300	K.M.A.	96	42	5	169	136	4	C.S.	U.F.	K.	+ 5.5
Hagneck	Switzerland	A.d.C.	4	3,715	32	20.5	1,180	K.	101	46	.....	187.5	150	6	C.S.	M.A.O.	E.	+10
Rophemel	France	A.d.C.	2	3,600	75	5.57	480	K.	59	38	1.95	375	102	6	C.S.	C.&G.	E.	+ 1.45
Neckargemund	Germany	E.W.	1	3,550	13	76	2,825	K.	177	.....	23	75	178	4	C.S.	M.A.O.	E.	.....
Pederobba	Italy	C.M.R.	1	3,500	29	22.5	1,230	F.B.	114	44	4	157	136	6	C.I.	U.F.	E.	+ 9
Freudenberg	Germany	J.M.V.	2	3,400	13.5	68.7	2,680	K.	180	.....	22	68.2	155	..	C.S.	M.A.O.	E.B.	.....
Almazan	Spain	A.d.C.	1	136	6.9	7.5	215	K.	55	24	0.7	214	224	3	C.I.	C.&G.	E.	0

United States

[1]A.C.—Allis-Chalmers Mfg. Co.
I.P.M.—Baldwin Southwark Corp., I.P. Morris Division
S.M.S.—S. Morgan Smith Co.
N.N.—Newport News Drydock & Shipbuilding Co.
J.L.—The James Leffel & Co.

Canada

[1]D.E.W. —Dominion Engineering Works
C.A.C. —Canadian Allis-Chalmers Co.
M.S.I. —S. Morgan Smith-Inglis Co.

Europe

[1]A.d.C.—Ateliers des Charmilles
E.W.—Escher Wyss Engineering Works
J.M.V.—J. M. Voith
V.K.—Verkstaden, Kristinehamn
V.K.M.—Verkstaden, Kristinehamn and Metallitschesky Zavod
V.K.T.—Verkstaden, Kristinehamn, and Tammerfors
V.K.N.—Verkstaden, Kristinehamn and Nydquist & Holm
V.K.F.—Verkstaden, Kristinehamn and A. B. Finshyttan
A.B.F.—A.B. Finshyttan
C.M.R.—C.M. Riva
R.S.—C.M Riva and Storek

Symbols

[2]K.—Kaplan; F.B.—Fixed blade; M.A.—Manually adjusted blade, unit shutdown; M.A.R.—Manually adjusted blade, unit running; K.F.—Kaplan, fixed blade; K.M.A.—Kaplan, manually adjusted; L.—Lawaczeck.

[3]C.S.—Cast steel; S.C.S.—Special cast steel; S.S.—Stainless steel; C.I.—Cast iron.

[4]C.G.M.—2 chipped and ground, 1 machined all over; C.&G.—Chipped and ground; M.A.O.—Machined all over; U.F.—Unfinished.

[5]E.—Elbow; H.—Hydraucone; M.—Moody type; C.—Conical; E.B.—Elbow, with horizontal baffle; K—Kaplan, has sharp cornered elbow.

[a] Three plants, each with one unit of similar dimensions.

[b] Rating at best efficiency 8,800 hp.; 12,000 hp. maximum at 26 ft. head; minimum head 18 ft.

[c] Maximum head. [d] Maximum head 78 ft. [e] Maximum head 66 ft.

Last year utility hydro-electric plants supplied a higher percentage of the total load in the United States than ever before. Horsepower installed in hydro plants has increased 100 per cent in United States and 180 per cent in Canada during the last twelve years

A Banner Year for HYDRO-ELECTRIC GENERATION

EVEN though water-power construction, like most other activities, was severely curtailed during the last twelve months, about 41 per cent of the power generated in utility company stations during that period was supplied by hydro-electric plants. This is the highest percentage for any year. Of the 83 billion kilowatt-hours generated, about 34 billion was produced by water power.

Loss of load, the difficulty of obtaining capital for new projects and the desire of power companies to conserve their financial resources have caused construction to be suspended on a number of large projects on which considerable work has been done. Projects of this type representing about 750,000 hp. exist in the United States.

Hoover Dam on the Colorado River is the one large project that is being actively pushed. Work on this job is about one year ahead of schedule. The four 50-ft. diversion tunnels have been completed, and the cofferdams are being constructed to unwater the dam site. Contracts for the penstocks have been let, and bids have been asked for on five 115,000-hp. and two 55,000-hp. turbines. Five of these units are the highest powered hydraulic turbines in the world. This project is planned for an ultimate installation of fifteen 115,000-hp. and two 55,000-hp. units or an aggregate capacity of 1,835,000 hp.

In the Canadian section of the St. Lawrence River, power development is progressing rapidly. On Oct. 1 the Beauharnois plant was put into operation with four 50,000-hp. units, operating under a head of 83 ft., and two 8,000-hp. service units. This project is planned for an ultimate capacity of 2,000,000 hp. and a deep waterway canal.

In new waterpower capacity, about 200,000 hp. was put into operation in the United States in 1932. Included in this are two 42,500-hp. units in the Safe Harbor plant on the Susquehanna River in Pennsylvania. In this plant the automatically adjusted-blade Kaplan turbines are the largest of that type in the world. The two units put into operation last year in the Rock Island plant have been tested this year. These turbines are of the propeller type with manually adjusted blades, adjustment

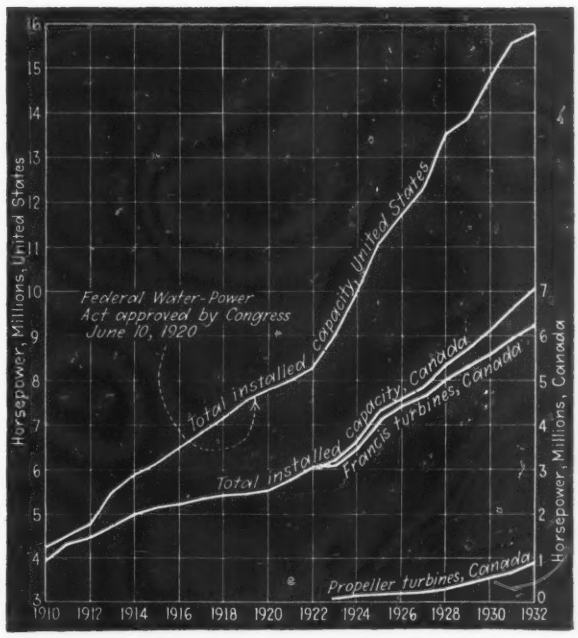

Horsepower, Millions, United States
Horsepower, Millions, Canada
Federal Water-Power Act approved by Congress June 10, 1920
Total installed capacity, United States
Total installed capacity, Canada
Francis turbines, Canada
Propeller turbines, Canada
1910 1912 1914 1916 1918 1920 1922 1924 1926 1928 1930 1932

Fig. 1—Curves of water-power growth in Canada and in the United States

being made with the units in operation. They are the highest capacity machines of their types constructed.

Eagle Pass plant, Eagle Pass, Tex., went into operation during the year with three 4,500-hp. units operating under an 81-ft. head. A notable feature of this plant is that a record turbine efficiency of 93.8 per cent was established for units of their rating, the water being measured under favorable conditions by Gibson method.

The Dnieper River plant in Soviet Russia is of interest to American engineers, since most of its equipment was built in the United States. This plant went into operation during the last year and when completed will have installed nine 84,000-hp. units, all of which have been built and shipped. In the Table, pages 22 and 23, the important features of this plant are given.

Even though 1932 cannot boast of the number of large water-power projects of previous years, there was an unusual interest in research and development of new equipment. One manufacturing company reports the development of a new type of propeller-type turbine in which the blades are adjusted automatically by the flow of water through them to the most efficient angle for any head and load within runner capacity. At starting the blades assume their maximum pitch position, giving a high starting torque with small gate opening, and gradually come to a closed position as the runner approaches normal speed.

Another new development is an adjustable-blade turbine with fixed gates. Regulation of the unit is obtained by the governor adjusting the position of the blades. There is no head cover over the runner, but in its place are the fixed vanes, which, on a vertical shaft runner,

Hydro-Electric Projects Completed and Under

Company	Designing Engineers	Project	[2]New or Redevelop	River	State	Project Started	[4]Initial Operation	Initial Capacity, Hp.	Added Capacity, Hp.	Ultimate Capacity, Hp.
Middle Atlantic States										
Safe Harbor Water-Pwr. Corp.	Pennsylvania Water-Pwr. Co.	Safe-Harbor	New	Susquehanna	Penn.	1929	1931	255,000	.....	510,000
								Station-	Service-Units	
U. S. Government	Corp. of Engineers U. S. Army	Lock and Dam No. 4	New	Monongahela	Penn.	1931	1932	120	.....	120
Beebe Island Corp.	Buffalo Niagara & Eastern Pwr. Corp.	Beebe-Island	New	Black	N. Y.	1931	1932	10,000	.....	10,000
F. L. Emerson	A. E. Ballin	Big Dam	Redev.	Owasco	N. Y.	1931	1932	1,100	.....	1,100
F. L. Emerson	A. E. Ballin	Dunn&McCarthy	Redev.	Owasco	N. Y.	1931	1932	1,000	.....	1,000
Paul Smith's Elec. Lt. & Ry. Co.	J. V. Dolan	Lake Placid	Redev.	Chubb	N. Y.	1931	1932	.....	.....	.....
Passaic Valley Water Comm.	.....	Little Falls	Redev.	Passaic	N. J.	1931	1932	3,600	.....	3,600
W. Va. Pulp & Paper Co.	.....	Mechanicville	.....	Hudson	N. Y.	1931	1932	10,500	2,900	.....
Lamoka Power Corp.	.....	Keuka	New	.....	N. Y.	1931	1933	3,000	7,000	30,000
East North Central States										
Ford Motor Co.	Ford Motor Co.	Ypsilanti	New	Huron	Mich.	1931	1932	2,500	.....	.....
Edison Sault Elec. Co.	Holland, Ackerman & Holland	St. Marys	New	St. Marys	Mich.	1931	1932	3,170	2,680	.....
U. S. Government	Corp. of Engineers, U. S. Army	Lock and Dam No. 15	New	Mississippi	Ill.	1931	1933	375	.....	.....
Maringo River Pwr. Co.	A. E. Appleyard	Maringo	New	Maringo	Wis.	1931	1933	250	.....	.....
South Atlantic States										
New Kanawha Pwr. Co.	.....	Hawks Nest	New	New	W. Va.	1930	1933	140,000	.....	140,000
City of Martinsville	Saville & Williamson	.....	Redev.	Smith	Va.	1931	1932	1,865	.....	.....
Georgia Power Co.	Georgia Power Co.	Furman Shoals	New	Oconee	Ga.	1930	.....	60,000	.....	60,000
Nantahala Pwr. & Lt. Co.	Aluminum Co. of America	Nantahala	New	Nantahala	N. C.	1929	.....	56,000	.....	56,000
West South Central States										
Central Tex. Hydro Elec. Co.	Fargo Engrg. Co.	Hamilton	New	Colorado	Tex.	1931	1933	30,000	.....	45,000
Central Pwr. & Lt. Co.	Harza Engrg. Co.	Eagle Pass	New	Rio Grande	Tex.	1931	1932	13,500	.....	13,500
Texas Hydro-Elec. Corp.	Fargo Eng. Co.	TP 4	New	Guadalupe	Tex.	1931	1932	3,320	.....	3,320
Mountain States										
Redlands Water Pwr. Co.	A. L. Robinson	Grand Junction	New	Colorado	Colo.	1931	1932	2,000	.....	2,000
Public Service Co. of Colo.	U. S. Bureau of Reclamation	Grand Valley	New	Colorado	Colo.	1932	1933	4,600	.....	.....
U. S. Bureau of Reclamation	U. S. Bureau of Reclamation	Hoover Dam	New	Colorado	Ariz. Nev.	1931	1937	685,000	.....	1,835,000
Montana Pwr. Co.	.....	Flathead	New	.....	Mont.	1930	.....	156,000	.....	134,000
Pacific Coast States										
City of Seattle	Lighting & Eng. Dept's	Diablo	New	Skagit	Wash.	1927	1934	166,000	.....	320,000
Puget Sound Pwr. & Lt. Co.	Stone & Webster Eng. Corp.	Rock Island	New	Columbia	Wash.	1930	1931	84,000	.....	210,000
Calif. Oregon Pwr. Co.	Byllsby Eng. & Mgmt. Co.	Prospect 3	New	Rogue	Ore.	1931	1932	10,000	.....	10,000
City of Los Angeles	Dept. of Water & Pwr.	San Francisquito No. 2	New	.....	Calif.	1931	1932	40,000	22,500	62,500
South Calif. Edison Co.	So. Calif. Edison Co.	Borel	Redev.	Korn	Calif.	1931	1932	7,200	.....	.....
U. S. Bureau of Reclamation	U. S. Bureau of Reclamation	Wippel	New	Yakima	Wash.	1931	1932	1,000	.....	.....
U. S. Bureau of Reclamation	U. S. Bureau of Reclamation	Prosser	New	Yakima	Wash.	1931	1932	4,200	.....	4,200
U. S. Indian Irrigation Service	Barry Dibble	Drop No. 3	New	Yakima	Wash.	1931	1933	1,700	.....	4,140
Mountain States Pwr. Co.	.....	.....	New	.....	Ore.	1932	.....	.....	.....	835
Alaska										
Portland Canal Pwr. Co.	Willis T. Batcheller	Davis River	New	Davis	Alaska	.....	1935	22,000	.....	94,000
Panama Canal Zone										
U. S. Panama Canal	U. S. Bureau of Reclamation	Madden Dam	New	Madden	Panama	1931	.....	22,400	.....	33,600
Foreign Countries										
Government of Soviet Russia	Hugh L. Cooper & Co.	Dnieper	New	Dnieper	.....	1927	1932	756,000	.....	756,000
Canada					**Province**					
Shawinigan Water & Pwr. Co.	Power Engrg. Co.	Rapide Blanc	New	St. Maurice	Que.	1930	1933	160,000	.....	240,000
Beauharnois Lt., Heat & Pwr. Co.	W.S. Lee, T.H. Hogg&F.B. Brown	Beauharnois	New	St. Lawrence	Que.	1929	1932	216,000	.....	636,000
Beauharnois Lt., Heat & Pwr. Co.	W.S. Lee, T.H. Hogg&F.B. Brown	Beauharnois	New	St. Lawrence	Que.	1929	1932	Station-	Service-Units	
Hydro-Elec. Pwr. Comm. of Ont. and Ottawa Valley Pwr. Co.	Chats Falls Eng. Board	Chat Falls	New	Ottawa	Que. and Ont.	1929	1931	224,000	.....	280,000
MacLaren Quebec Pwr. Co.	Hardy S. Ferguson & Co.	Masson	New	Lievre	Que.	1931	1933	136,000	.....	136,000
Town of Meganitie	.....	.....	.....	.....	Que.	1932	.....	.....	.....	500
Ontario Pwr. Service Corp.	George F. Hardy	Abitibi Canyon	New	Abitibi	Ont.	1930	1933	330,000	.....	330,000
								Station-	Service- Units	
City of Calgary	.....	.....	.....	.....	.....	1932	.....	1,120	.....	.....
British Columbia Pwr. Corp.	British Columbia Pwr. Corp.	Bridge R.	New	Bridge	B. C.	1927	.....	56,000	.....	560,000
W. Kootenay Pwr. & Lt. Co.	W. Kootenay Pwr. & Lt. Co.	Corra Linn	New	Kootenay	B. C.	1930	1932	57,000	.....	57,000

[1]A. C. — Allis-Chalmers Mfg. Co.
M. S. — S. Morgan Smith Co.
J. L. — James Leffel & Co.
P. W. — Pelton Water Wheel Co.
I. P. M. — Baldwin Southwark Corp., I. P. Morris Division
N. N. — Newport News Shipbuilding & Dry Dock Co.
W. — Woodward Governor Co.
G. E. — General Electric Co.
W. E. — Westinghouse Elec. & Mfg. Co.
E. M. — Electric Machinery Mfg. Co.
D. E. W. — Dominion Engineering Works
C. A. C. — Canadian Allis-Chalmers Co.
M. S. I. — S. Morgan Smith-Inglis Co.
C. W. E. — Canadian Westinghouse Co.
C. G. E. — Canadian General Electric Co.

are placed in nearly a horizontal position. This design is particularly adapted to open-flume settings and is intended to meet the need for a turbine that will permit modernization of small hydro plants at low cost.

Considerable attention has been given to the development of a combination pump and turbine unit for use in pumped-storage plants. With this type of unit the runner will operate in one direction for power generation and in a reverse direction for pumping. At a meeting of the Middle Eastern District of the American Institute of Electrical Engineers, F. A. Allner, of the Pennsylvania Water & Power Company, presented the results of experiments with different types of runners used for the dual purpose of turbine and pump. These experiments showed that the Kaplan-type runner was the best adapted to dual use.

One manufacturer reports the development of a pump-turbine for dual operation. An experimental model run-

No. of Units Installed	Waterwheel Capacity, Hp.	Type	Speed R. p. m.	Static Head, Ft.	Design Head, Ft.	[1]Waterwheel Manuf.	[1]Governor Manuf.	Draft Tube, Type	Scroll Case, Type	Surge Tank	Relief Valve	Generator Capacity, Kva.	[3]Thrust Bearing Location	Power Factor	Kilovolts	Cycles	[1]Generator Manuf.
						3-M. S.											4-G. E.
6	42,500	Kaplan	109.1	55	55	3-I. P. M.	W.	Elbow	Concrete	.....	.....	36,000	B. G.	0.80	13.8	60	2-W. E.
2	3,100	Francis	180	.....	.....	M. S.	W.	Elbow	Concrete	.....	.....	2,500	B. G.	0.70	0.48	60	W. E.
3	40	Francis	100	16.7	16.7	J. L.	W.	(One turbine drives a 25-K.W. 250-volt direct current generator and two drive oil pumps through speed increasers.)									
2	5,000	1-Kap. 1-Prop.	150	32–29	32	I. P. M.	W.	Elbow	Concrete	.....	.....	5 000	.....	0.80	2.4	60	G. E.
1	1,100	Kaplan	257	26	26	M. S.	M. S.	Elbow	.....	.....	.....	1,000	.....	0.80	2.4	60	G. E.
1	1,000	Kaplan	257	23.5	23.5	M. S.	M. S.	Elbow	.....	.....	.....	875	.....	0.80	2.4	60	G. E.
1	400	Kaplan	257	.....	16	M. S.	W.	Elbow	.....	.....	.....	375	A. G.	0.80	2.4	60	G. E.
4	900	3-Prop. 1-Kap.	360	33.5	32	A. C.	A. C.	Elbow	Concrete	.....	.....	750	A. G.	0.80	2.4	60	A. C.
2	1,445	Kaplan	214	24	24	M. S.	M. S.	Straight	Open flume	.....	.....	1,900	A. G.	0.80	0.48	25	G. E.
2	7,000	.....	.....	390	385	J. L.	W.	.....	.....	.....	.....	6,250	.....	0.80	2.3	60	E. M.
2	1,650 850	Francis	150 225	35	33	J. L.	W.	Elbow	Concrete	.....	.....	1,600 800	.....	0.80	4.6	60	W. E.
1	2,680	Prop.	128.5	17	17	A. C.	A. C.	.....	.....	.....	.....	2,500	B. G.	0.80	4.0	60	G. E.
1	375	Prop.	180	18	18	M. S.	W.	Conical	Open flume	.....	.....	312	A. G.	0.80	0.48	60	G. E.
1	250	Francis	720	80	80	J. L.	J. L.	.....	.....	.....	.....	175	.....	....	2.3	..	G. E.
4	35,000	Francis	150	.....	157	I. P. M.	.....	.....	.....	.....	.....	30,000	B. G.	0.85	6.9	25	W. E.
1	1,350	Kaplan	300	30	30	M. S.	M. S.	.....	.....	.....	.....	1,250	A. G.	0.80	4.0	60	G. E.
1	515	Francis	277	30	30	M. S.	M. S.	.....	.....	.....	.....	375	A. G.	0.80	4.0	60	G. E.
2	30,000	Francis	100	92–45	92–45	M. S.	M. S.	Elbow	.....	.....	.....	25,000	B. G.	0.90	6.9	60	G. E.
1	56,000	Francis	512	965	920	.....	.....	Elbow	Cast st.	Diff.	.....	45,000	A. G.	0.90	13.0	60	.....
2	15,000	Francis	171.4	126	110	M. S.	W.	Elbow	Plate st.	.....	.....	12,500	B. G.	0.80	13.8	60	W. E.
3	4,500	Francis	225	81	81	J. L.	W.	Elbow	Plate st.	.....	.....	3,200	B. G.	0.80	6.9	60	W. E.
1	3,320	Kaplan	180	29	29	M. S.	M. S.	Elbow	Flume	.....	.....	3,000	.....	0.80	2.3	60	G. E.
1	2,000	Prop.	.....	.....	35	M. S.	W.	.....	.....	.....	.....	1,500	B. G.	0.85	2.3	60	G. E.
2	2,300	Francis	300	73–79	73	P. W.	P. W.	Elbow	Plate st.	.....	.....	1,875	A. G.	0.80	2.3	60	E. M.
5	115,000	Francis	150	604–425	590–420	.....	.....	Elbow	Cast st.	.....	.....	.....	.....	....	....	..	.....
2	55,000	Francis	257	604–425	590–420	.....	.....	Elbow	Cast st.	.....	.....	.....	.....	....	....	..	.....
..	78,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	....	....	..	.....
2	83,000	Francis	171.5	327–247	310	M. S.	M. S.	Elbow	Cast st.	Johnson	Pres. Reg.	66,700	A. G.	0.90	13.8	60	W. E.
4	21,000	Propeller	100	51–20	32	A. C.	A. C.	Concrete	.....	.....	.....	16,667	B. G.	0.90	13.8	60	G. E.
1	10,000	Francis	720	720	697	P. W.	P. W.	.....	Cast st.	.....	Gov. Op.	9,000	A. G.	0.80	6.9	60	A. C.
3	22,500	Francis	428	540	530	N. N.	W.	Conical	Cast st.	.....	Gov. Op.	17,500	A. G.	0.80	6.6	60	A. C.
1	7,200	Francis	428	270	270	P. W.	W.	Elbow	Cast st.	.....	.....	6,250	A. G.	0.80	2.2	50	G. E.
2	500	Francis	500	87	83	N. N.	.....	Conical	Cast st.	(These two wheels are of the horizontal-shaft type and connect directly to pumps.)							
1	4,200	Prop.	200	42–32	40	N. N.	W.	Elbow	Plate st.	.....	.....	3,750	A. G.	0.80	2.4	60	G. E.
2	850	Prop.	400	34	34	P. W.	P. W.	Conical	Concrete	.....	.....	850	A. G.	0.80	2.3	60	A. C.
1	.....	Prop.	164	15	15	A. C.	W.	.....	Flume	.....	.....	.....	.....	....	....	..	.....
2	18,000	Francis	450	410	400	.....	.....	Elbow	Cast st.	.....	Gov. Op.	15,000	A. G.	0.80	6.6	60	.....
	It is planned eventually to increase the head on this project to 600 ft., under which condition the units will have a capacity of 23,500 hp.																
2	11,200	Francis	214.2	145–75	120	A. C.	W.	Elbow	Plate st.	.....	.....	10,000	A. G.	0.80	6.9	25	G. E.
9	84,000	Francis	88.2	123–96	.....	N. N.	W.	Elbow	Plate st.	.....	.....	77,500	A. G.	0.80	13.8	50	G. E.
4	40,000	Francis	109.1	117–93	108	D. E. W.	D. E. W.	Moody	Plate st.	.....	.....	36,000	B. G.	0.85	11.0	60	C. W. C.
4	53,000	Francis	75	83	80	D. E. W.	D. E. W.	Elbow	Concrete	.....	.....	46,625	B. G.	0.80	13.2	60	C. G. E.
..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	43,482	B. G.	0.85	13.2	25	C. G. E.
2	8,000	Francis	180	83	80	D. E. W.	D. E. W.	Elbow	Concrete	.....	.....	7,200	.....	0.80	13.2	60	C. G. E.
8	28,000	Prop.	125	58–38	53	D. E. W.	D. E. W.	Elbow	Concrete	.....	.....	23,500	A. G.	0.85	13.2	25	C. W. C.
4	34,000	Francis	166.7	203–186	185	C. A. C.	W.	Elbow	Plate st.	Johnson	.....	28,000	A. G.	0.85	13.2	25	C.W.C.
1	500	Prop.	300	21	21	C. A. C.	W.	Hy'Cone	Flume	.....	.....	.....	.....	.....	.....	.....	.....
5	66,000	Francis	150	247	237	C. A. C.	C. A. C.	.....	Plate st.	.....	.....	48,500	A. G.	0.85	13.8	25	C. G. E.
1	600	Francis	750	247	237	C. A. C.	W.	.....	Cast st.	.....	.....	.....	.....	.....	.....	.....	.....
3	2-450	Prop.	450	52	52	C. A. C.	These three units drive pumps, are regulated by hand and have tapered plate steel draft tubes.										
..	1-120	Prop.	790	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1	56,000	Impulse	.....	1,224	1,097	.....	.....	.....	.....	.....	.....	45,000	.....	0.90	13.2	60	.....
3	19,000	Francis	85.7	53	53	D. E. W.	D. E. W.	Elbow	Plate st.	.....	.....	15,000	A. G.	1.00	7.2	60	C. G. E.

[2]The term "New" applies to an entirely new project on a site that has not been developed previously. "Redevelop" indicated a project on a site that has been developed previously and may consist of new wheels and settings on an entirely new plant.

[3]A. G. indicates that the thrust bearing is above the generators rotor; B. G., thrust bearing located below the rotor.

[4]There are a few plants in the table that have their initial operation given as of 1931. In these plants the first unit was started late in the year and the initial installation in the plant was completed in 1932.

ner 18 in. in diameter gave an efficiency of 89.3 per cent as a turbine and 85.5 per cent at a pump. During these tests the pump was operated at a higher speed than the turbine. For pumped-storage projects permitting the use of low-specific-speed francis runners, it is reported that there are no engineering obstacles preventing the use of reversible dual-speed hydro-electric units with high efficiency under both conditions of operation.

In the field of research, much commercial work is in progress or has been completed, and hydraulic laboratory facilities have been greatly extended. The National Hydraulic Laboratory at Washington, D. C., was put into service during the year, and work has been started on several research projects. Tulane University, New Orleans; University of Tennessee, Knoxville, Tenn.; McGill University, Montreal; and the Montreal Polytechnic School reported putting into operation new hydraulic laboratories. Another outstanding achievement

for research during the year was the dedication of Canada's $3,000,000 National Research Laboratory at Ottawa. In connection with this laboratory is a towing tank 400 ft. long for hydraulic experimental work.

One waterwheel manufacturing company reports that its present hydraulic testing flume has been in continuous use during the year. Plans are also being prepared by that company for a new laboratory in which provisions are being made for testing turbine and pump models and to study cavitation. Another manufacturer announced a new hydraulic laboratory building and has facilities for making cavitation tests through one of its associated companies in Canada.

The Kaplan turbine has made the problem of cavitation one of outstanding moment in this country, as this phenomenon is a limiting factor affecting design for maximum capacity and causes damage to turbine parts in operation. A fundamental study of this problem is being made by Prof. Wilhelm Spannhake in the cavitation laboratory at Massachusetts Institute of Technology. Its effect on hydraulic-turbine operation is being investigated on model runners in the hydraulic laboratory at the Holtwood plant of the Pennsylvania Water & Power Company and on the 42,500-hp. propeller-type turbines at the Safe Harbor plant.

The table, page 20, is an interesting part of this review, as it lists the outstanding propeller and Kaplan turbines of the world. From this tabulation it is evident that while the Kaplan-type turbine with automatically adjusted blades is largely a European development, the fixed-blade type is the product of engineers in the United States and Canada.

The first commercial installations of propeller-type turbines in the United States were two 600-hp. units for a 15-ft. head installed near Geddes, Mich., in 1916. The first Kaplan turbine installation was made in Europe in 1919. For the first large propeller-type turbines under a comparatively high head, credit goes to Canada in two 28,000-hp. units for a 58-ft. head, contracted for in 1922. Since that time over 860,000 hp. in propeller-type turbines have been installed in that country and about the same in the United States, where the highest-powered Kaplan turbines are operating in the Safe Harbor plant.

With the exception of the Safe-Harbor turbines most of the outstanding Kaplan turbine installations are in Europe, where they are in operation for heads up to 76 ft. and are being designed for operation under a maximum head of 106 ft. in the River Shannon plant in Ireland. The highest powered turbines in Europe are in the Ryburg Schwörstadt plant on the Rhine, which has four 37,800-hp. units to operate under a 37.7-ft. head. The two 15,200-hp. Vargon units in Sweden hold the record for dimensions, having runners 315 in. in diameter, and the 136-hp. unit in the Almazon plant in Spain has a specific speed of 224, the highest reported.

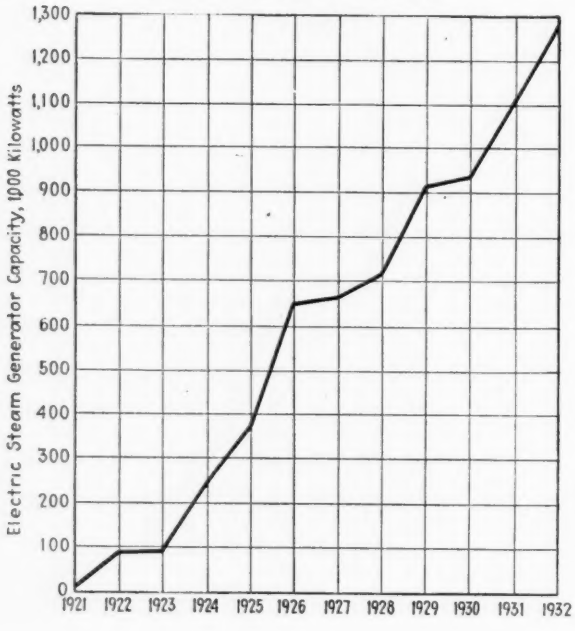
In propeller-type turbines of all designs there is approximately 3,500,000 hp. installed or on order in the world, about equally divided on the two sides of the Atlantic. Outstanding installations are fairly equally divided between the two continents. The table lists 22 projects in the United States with an aggregate capacity of 640,000 hp., 11 projects in Canada having 796,000 hp., and 33 projects in Europe totaling 1,245,000 hp.

In Fig. 1 are curves showing the growth of installed capacity in water-power plants in the United States and Canada from 1920 to date. The curves are plotted on the total horsepower installed at the ends of the years indicated. Beginning with 1922, the curve for the United States has a very sharp upturn which has continued up to this year. This rise can be accounted for by the rapid industrial expansion during that period and the Federal Water Power Act, which became law in June, 1920. Since Congress passed that Act, the capacity installed in water-power plants has more than doubled, being 7,800,000 hp. at the end of 1920 and 15,800,000 hp. at the close of 1932. The curve for Canada also shows a sharp rise since 1923, which is accounted for by the rapid industrial expansion in that country during the last 12 years. The growth in water power has been even more rapid in Canada than in the United States. In 1920 in Canada there was installed 2,515,559 hp., while at the close of last year the figure was 7,035,337 hp., or 180 per cent increase, as compared to about 100 per cent in the United States during the same period.

The figures shown on the curves for total installed capacity in the United States are those made available by the U. S. Geological Survey and in Canada by the Dominion Water-Power and Hydrometric Bureau.

The use of electric steam generators has contributed in a large measure to the growth of water-power development in Canada. A curve, Fig. 2, has been plotted to show the growth in the use of electric steam generators in that country, which has increased from a 10,000-kw. installation in 1921 to 1,275,000 kw. at the end of 1932. In the last two years over 360,000 kw. of electric steam-generator capacity has been put into operation or is on order. This has been installed in a large measure to absorb excess power made available by the loss of industrial load due to the depression. In addition to the electric steam-generator capacity in Canada there are 66,000 kw. in a Newfoundland paper mill. Information for compiling the electric steam-generator curve was supplied by the Dominion Engineering Works, Montreal, and the Canadian General Electric Co., Toronto. For a further discussion of electric steam generators see the article, "Electric Steam Generators Use Excess Hydro Power," in the December number of *Power*.

Fig. 2—Curve of electric steam-generator growth in Canada



SMOKE AND PURE AIR

ACTIVITIES MARK TIME

SMOKE abatement problems during 1932 were not as prominent as in years of greater industrial activity. This is equally true of the entire pure air question. Not that there is less understanding or interest in the prevention of smoke, fly ash, cinders and sulphur but simply that there has not been the usual manifestation of nuisance.

Only one completely new public utility power plant is known to have been contracted for last year. This is the Buzzards Point installation of the Potomac Power Company at Washington, D. C. It will burn pulverized coal, and included in the original design is a complete Cottrell electrical precipitator equipment for removing fly ash.

The Kneeland Street steam station of the Edison Electric Illuminating Company of Boston has reported the successful operation of a wet scrubbing system for removing solids from stack discharge.*

Considerable attention is being paid to wet washing systems, both here and abroad. A report from Germany mentions, in particular, the satisfactory progress of research and experimentation in the washing of dust-laden gases by a system which promises to use very small amounts of water.

It is apparent that progress is being made also in dust collectors of the cyclone type. By and large, however, there is no indication that thought or procedure in the collection or prevention of solids in gas streams has been reduced to rational terms by all power engineers. In general, the engineers are inclined to recommend equipment of ample capacity and high efficiency for the duties required. But not infrequently, those in charge of expenditures are apt to lean toward the appearance of conforming to smoke abatement requirements, by installing equipment too small for the service, hence with some sacrifice of efficiency to price.

A distinct condition of the present time is indicated by a willingness, on the part of many persons directly concerned, to let the whole question of smoke, dust, cinder and sulphur prevention lie fallow during the present depressed industrial conditions. This inactivity has been added to, in no small extent, by the action of several important cities which have discontinued or otherwise rendered ineffective their smoke abatement departments for economic or political reasons.

The question of finding a commercial use for collected fly ash from power stacks is still bothersome and little progress is to be reported beyond the previous statement that the greatest hope seems to lie in the manufacture of building bricks.

One manufacturer reports very satisfactory reception of a patented machine recently put upon the market for removing excess moisture in coal. Where there is need for this class of service in the power field, the hot gases from the stacks are used, thus providing heat at low cost with good possibility of removing all soot and carbon from the gases before their final discharge to the atmosphere.

England and Germany continue to show great interest in the whole subject, although research in those countries, as well as elsewhere, is at a slower pace than previously. The City of London has established a Department of Scientific and Industrial Research and a subsidiary Atmospheric Pollution Research Committee. The Federal Coal Council of Germany is also doing active work. In this country, the U. S. Department of Public Health has instituted a broad research project in fourteen important cities, for the purpose of measuring solids in the atmosphere by standardized methods, which will make all the results directly comparable.

Research has also been extended into methods for the measurement of solids in gas streams. The Stevens Institute of Technology, with the assistance and active cooperation of the Interborough Rapid Transit Company, the New York Steam Company and the New York Edison Company, has put in more than a year of intensive work upon this one subject. Research studies are also being made upon the same subject in the research laboratories of some of the most important universities.

The question of finding a commercially possible method for removing sulphur from the gases of combustion has continued to receive the research attention of many persons, including Prof. H. F. Johnstone of the University of Illinois, although progress has been held down generally on account of finances. It seems to be generally agreed that Professor Johnstone's method offers one of the best possibilities of reducing the whole problem to a commercial possibility, through the utilization of manganese as a catalyst.

A good proportion of the research activity among the commercial organizations during the past year has been devoted to the subject of dust, smoke, fly ash, cinder and sulphur collection from the discharge of industrial gases of all kinds. This is a good indication of the effectiveness with which the problem will be met when it again becomes a more important issue than it is now.

Vital statistics collected for the first nine months of 1932 show a marked reduction below the previous mortality minimums both in the United States and Canada especially in respiratory and pulmonary diseases, while diseases of other types have maintained practically normal averages.

If, as is being claimed, the lower mortalities in the respiratory and pulmonary cases are the result of better atmospheric conditions and these in turn are the result of less atmospheric pollution from industry, the reports take on a new importance.

*See *Power* for August, 1932.

ELECTRICAL DEVELOPMENTS

EMPHASIZE IMPROVED OPERATION

ALTHOUGH the central station load in the United States decreased to 83 billion kilowatt-hours, a loss of 10 per cent from 1931 load, and the electrical manufacturers experienced large curtailment in orders, 1932 will go down in electrical history as a year of many accomplishments. Electrical manufacturers have been active in developing new equipment and in making improvement in their old lines to reduce cost and increase efficiency. These include new types of motors and control, improved switching equipment, new insulating materials, new applications of electronic tubes, improved testing methods, greatly extended metering facilities, new materials and many other advances that make for greater operating economy and reliability.

Outstanding in large equipment put into operation are the two 160,000-kw., 0.80-power-factor generators put into service in the Hudson Avenue station of the Brooklyn Edison Company. Of high-speed units put into service, the 18,000-kw., 0.80-power-factor, 3,600-r.p.m. generator in the Burlington station of the Public Service Electric & Gas Company is the most notable, as it is the largest machine of that speed in operation. At present another manufacturer is building two 25,000-kw., 0.80-power-factor units for 3,600-r.p.m. operation. These are the largest for that speed under construction. In Europe, generators of 60,000-kw. capacity for 3,000 r.p.m. have been built. This speed is possible because the 50-cycle system is in use.

Up until a few years ago, 13,800 volts was the maximum generator voltage in general use. Since then, both in this country and in Europe, there has been a tendency to use higher generator voltages. One large electrical manufacturing company in the United States reports having built ten steam-turbine driven generators with voltages of 16,500 and above, seven of which are for 22,000 volts. In England two 30,000-kw. machines have been installed in the Swansea municipal plant that operates at 33,000 volts. Four units in three other plants operate at 32,000 to 36,000 volts.

In power transmission, although 220,000 volts is still the highest in use, the study of lightning has been facilitated by a 10,000,000-volt lightning generator, which has a higher energy and voltage output than any machine of this type so far constructed. This generator makes possible investigation of approximate direct strokes of lightning on transmission lines and connected apparatus under a reproduction of the worst conditions encountered in service.

An advance made in testing equipment to determine how well it will stand up against lightning and other surges was a recently announced combination of power and surge test for transformers, which duplicates operating conditions. This is accomplished by having the transformer's windings excited at the peak of the power voltage wave when the surge test is applied. With this test the power current will follow in the path of any winding failure produced by the surge that would be likely to cause trouble in service.

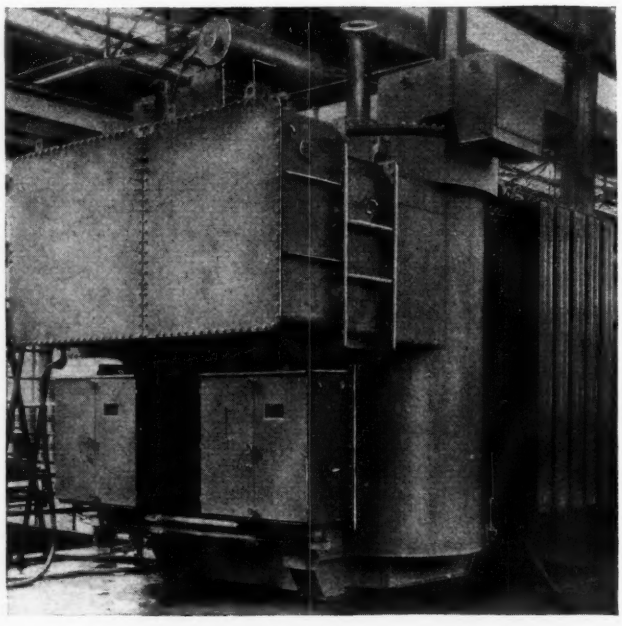
A number of power transformers of exceptional ratings and physical dimensions were built during the year. One of these was a 60,000-kw. oil-air-pressure single-phase unit. Other units of urusual interest are two 40,000-kva., three-phase regulating transformers installed by the United Electric Light & Power Company, New York City. These units operate in two of the several feeders between Hell Gate and the Hudson Avenue generating stations. Their design embodies the feature of simultaneous phase angle and voltage regulation in either a buck or a boost position, so that power may be transferred from either station to the other.

For use in transformers, circuit breakers and other devices depending upon oil as an insulator, a non-inflammable and non-explosive insulating liquid has been developed. This liquid can be substituted for insulating oil in installations where other methods of minimizing explosions or fire risk are not feasible. It has already been used in several low-voltage transformers and in manufacture of static capacitors.

The use of mercury-arc rectifiers continue to expand, and it is possibly only a matter of a few years until they will almost entirely replace rotary converters. The sectional type of large rectifier announced one year ago has been further improved. An assembly has been developed in which each section has been fitted with a complete set of auxiliaries and truck-type contacts for both anodes and cathodes, so that it is only a matter of seconds to remove one or more sections from the operating position and make the remainder of the rectifier available for operation.

Great progress has been made during the past twelve

One of two 40,000-kva., 3-phase regulating transformers installed by the United Electric Light & Power Company in New York City



Improved methods of testing, non-inflammable insulating liquids, important advances in the use of electronic tubes for power transmission and applications, and advances in motors and mechanical power transmission equipment design — these are outstanding developments

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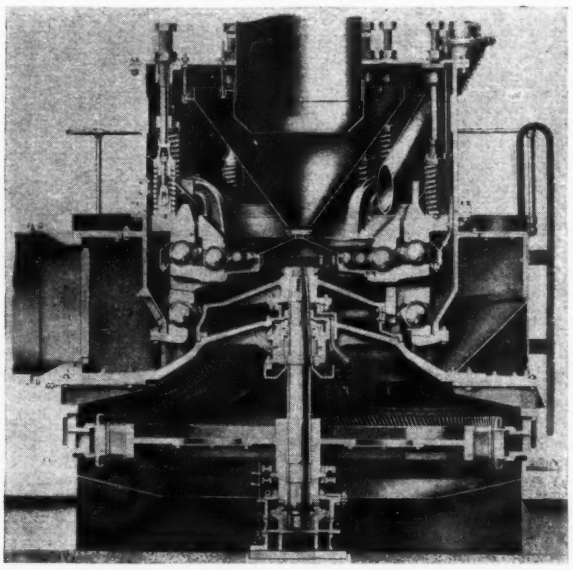


Vertical 500-hp., 72-r.p.m. synchronous motor installed below 51-ton per hr. coal pulverizer by New York Steam Corporation

months in applying electronic tubes to control problems and to power transmission and distribution. Some of these tubes are being built in very large capacities. One tube, of the Thyratron type, using a pool of mercury as the cathode, has 12 anodes with a combined normal capacity of 5,000 amp. direct current and an overload capacity up to 14,400 amp. at 1,500 volts.

One of the promising fields for the application of these tubes is in power transmission, where one set of tubes will convert high-voltage alternating current into direct-current for transmission, and another set at the other end of the line will convert the high-voltage direct-current into alternating current for distribution. A 400-kw. rectifier and inverter takes power from an 11,000-volt line, rectifies it to 12,500 volts direct current and inverts this direct current to 60-cycle alternating current that is used to run a 400-kw. rotary converter. Another rectifier-inverter unit is rated at 500-kva., operates at zero power factor and acts as a synchronous condenser on a 4,000-volt alternating-current line. A 400-hp. synchronous motor supplied by electron tubes has its speed varied by using the tubes to vary the frequency of the power to motor. The installations mentioned are of a laboratory nature, but they indicate the developments taking place in this class of equipment. The largest commercial installation of electron-tube rectifiers is of the Phanotron type, installed by the Boston Edison Company. It takes power from a 13,800-volt, three-phase, 60-cycle, alternating-current system and supplies 600 amp. to a 3-wire, direct-current system.

In electrical precipitation of dust from power-plant flue gases and gases from industrial processes a high-voltage direct current is required, and electronic tubes have been applied to this service. One of these equipments is capable of delivering from a 25-cycle source 400 milli-amperes average value at a maximum potential of 100,000 volts. Single-phase, full-wave rectification is used, requiring four electronic tubes which are mounted on the transformer.

One of the chief developments in general-purpose motors has been the decided trend to gear-motors, that is, a speed reducer and a motor designed and assembled as a unit. Several electrical manufacturers placed on the market during the last year units of this type. Frequently the gears are overhung from the motor, and in other designs the motor is supported from the speed reducer, depending on the speed reduction.

Synchronous-Motor Applications

The power-factor problem continues to attract attention. Because of more favorable rates for high power-factor loads and other economic considerations, many industrial plant operators are finding it to their advantage economically to maintain the power factor of their loads at a high value. In this, the synchronous motor is becoming increasingly important. These motors are being designed to meet practically every condition where constant-speed medium- and large-capacity drives are required.

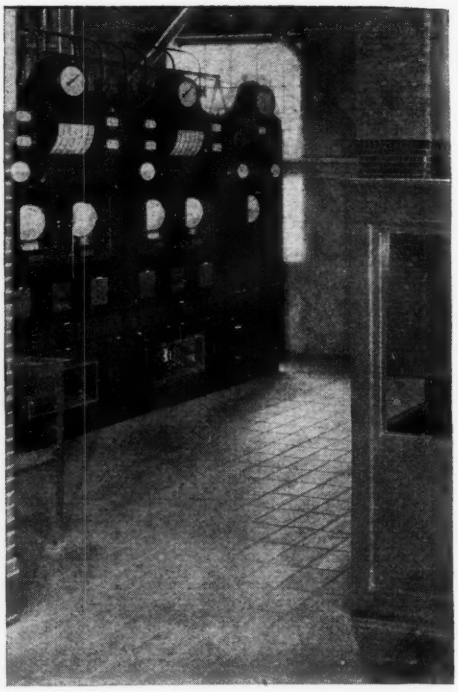
Where conditions will permit, slow- and medium-speed motors are frequently started by connecting them directly to the line. Where the power system will not permit doing this, some form of reduced voltage starting is used. One of these is part-winding starting, in which only part of the stator winding is connected initially to the line.

As an example of how this type of starting has been applied, the case of two 1,250-hp., 0.90-power-factor, 225-r.p.m., 2,300-volt motors driving pulp grinders at the end of a 135-mi. transmission line may be cited. The power company decided that starting these motors would not cause serious disturbance in the system if the total inrush did not exceed 1,500 kva., or 140 per cent of full-load value, providing that this could be reduced in increments not exceeding 375 kva. This problem was solved by the use of part-winding starting. The motors were designed with four parallel circuits in the stator so that this winding can be connected to the line in four increments. This has met the requirements of the power company.

One company reports that one of its main developments in synchronous motor applications in 1932 has been in the extensive use of automatic instantaneous underloaders for ammonia compressors. These unloaders eliminate the necessity of hand bypassing the compressor, thereby permitting automatic compressor operation. In addition, they instantly unload the rotor in case of voltage dips. If the motor stops it can start the compressor immediately after the voltage is normal.

Although considered several years ago, one company reports that it has recently successfully applied built-in vertical synchronous motors to large coal pulverizers. The first unit installed was designed to pulverize 40 tons of coal per hour and was driven by a 500-hp., 72-r.p.m. synchronous motor. This unit now handles 51 tons per hour with an average energy saving of about 37 per cent under the best previous practice.

METERING AND CONTROL SYSTEMS IMPROVED BY CENTRALIZATION



Increased use of devices for automatically controlling combustion process, reheat temperatures, division of load between turbine generators operating in parallel and other steam plant operations — Metering equipment concentrates essential records on one chart — All turbine- and boiler-room meters and control centralized

SEVERAL important events marked power-station control and metering during the past twelve months. The world's largest stokers went into operation equipped with automatic combustion control at the Hudson Avenue Station of the Brooklyn Edison Company. There are eight of these units firing boilers to supply steam to two 160,000-kw. turbine generators. Automatic control of the new boilers is tied integrally with that for the boilers supplying steam to units Nos. 4, 5 and 6 through master-control equipment. In addition each individual row of four high-pressure boilers has its own section master.

Individual windboxes with individual manual control for the distribution of air to each retort of underfeed stokers have been in operation for some time at the Beacon Street heating plant of the Detroit Edison Company. A similar system of metered-zone air control, improved in the light of previous experience, with air-flow control made automatic, has been installed on the stoker at the company's Delray No. 3 generating station. The windboxes on these stokers are divided into 60 sections, each with an orifice and a control damper. The orifice does the metering and the control damper regulates the air volume.

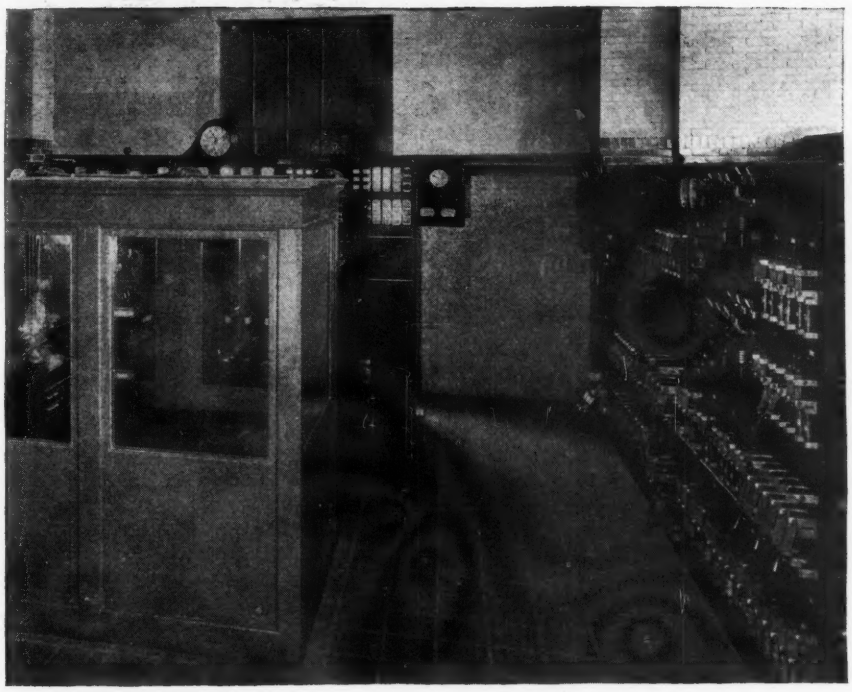
At Purdue University a series steam generator has two circuits of seamless steel tubing supplied with feed water at one end and delivering steam from the other at any pressure up to 3,500 lb. per sq.in. and at a maximum temperature of 830 deg. F. This boiler is equipped with a system of automatic combustion control in which Thyratron tubes are the source of power for the elements that regulate the supply of fuel, air and water. The mechanism for actuating the control is operated through Selsyn sending and receiving units. Because Thyratrons are used to provide the source of power and Selsyns transmit the impulses to actuate the control equipment, this system is of unusual interest and opens up wide possibilities for future developments in this direction.

Increases in boiler ratings during the last decade have brought with them correspondingly larger auxiliaries, controls and boiler-room dimensions. As a consequence a point has been reached in the layout of many plants where boiler operation by unaided man power has become practically impossible because of the effort necessary to manipulate some of the equipment and the distances between the various controls. This condition has been one of the factors that have led to extensive use of automatic combustion control.

Some power-plant designers are unwilling to adopt full-automatic equipment because of conservatism or their belief that conditions in a particular plant do not warrant the expenditure for its installation. Under such conditions it is becoming common practice to provide remote pushbutton operation on some or on all boiler auxiliaries and controls. This control substitutes mechanical for man power in operating the various dampers, throttle valves or rheostats, and centralizes the means for directing the application of this power.

Increasing attention is being given to the automatic control of reheat temperatures in high-pressure stations. A complete anticipatory control system that regulates reheat temperatures over a wide variation in plant demand by desuperheating and adjusting steam flow into the reheater was announced during the year as going into service in Station A of the Pacific Gas & Electric Company. Normally the exhaust from the high-pressure turbine goes through the steam reheater and then through the flue-gas reheater from which it goes to the low-pressure turbine.

Regulation of the reheat temperature is, within certain limits, controlled by bypassing steam around the reheater. When this operation has been carried to its limit a portion of the steam is desuperheated before it goes to the flue-gas reheater. All these operations are



Control switchboard, on main operating floor level, in full view of boiler and turbine equipment in Gilbert station of the New Jersey Power & Light Company

controlled automatically, as will be described in an article in an early number.

When waste-heat boilers operate on furnaces where the heat flow may vary widely, such as on oil-gas generators, the feed-water level in the boiler may be caused to vary rapidly. The conditions may be such that the simple water-level regulator that is entirely effective in normal boiler-plants may prove inadequate on waste-heat boilers. The latter problem has been solved by the development of a new series-type regulator, combining two thermostatic feed-water regulators, one operated by water level, and the other by steam flow. This arrangement has proved successful in preventing extremes of high and low water, reduced the fluctuations of feed-water demand, made the steam rates of waste-heat boilers more uniform and reduced load fluctuations on the fuel-fired boilers.

For manufacturing processes requiring large amounts of low- or medium-pressure steam it is general practice to obtain this from the exhaust or intermediate stages of turbines supplied from high-pressure boilers. The turbines usually drive generators and may be operated under any one of a number of conditions, each of which requires a special type of control to balance the steam and power demands and to prevent one from interfering with the other. Increasing attention is being given to making these operations entirely automatic, and last year saw further developments along these lines.

Division of the load between the different units in a plant supplying a power system offers large opportunities for improving the over-all economy of operation. This has probably been more generally realized in hydro-electric plants than in steam plants. The possibilities are greatest where the machines have unlike characteristics. The tendency is toward making division of load between the units automatic according to a prearranged schedule. Such systems have been applied to hydro-electric plants, and last year a full automatic program load control was announced as being in operation in the Colfax station of the Duquesne Light Company near Pittsburgh, Pa.

In this plant are two 60,000-kw., two 45,000-kw. and two 35,000-kw. units, each pair having different water rates. The program load control automatically divides the load between the steam turbines to maintain highest station efficiency at all loads. This system of program load control is applicable to power stations that do not operate on base load and must therefore follow system load changes. The economies obtained by using automatic program load control are dependent upon the divergence in heat rates of the several units in the plant and on the characteristics of the daily load curve.

There is an ever-increasing appreciation of the value of good meter records in plant operation. Good records of all functions of plant performance provide the knowledge necessary to lowest-cost operation. An outstanding development in power plant metering is the grouping of meters and control of both turbines and boiler room at a central location.

Elimination of the wall between the turbine and boiler rooms has made it possible to locate the meter and control room on the main operating floor level in full view of both boiler and turbine equipment, as was done in the Gilbert station of the New Jersey Power & Light Company. This arrangement puts the boiler-room and turbine operators close together, making it easy for each to become familiar with the other's duties and thus to facilitate coordination in operation.

Centralized Metering

This tendency to concentrate the control and metering at a central location is reflected in new designs of metering equipment now being made available. Systems of metering have been developed that permit the grouping of all essential records on one panel centrally located, irrespective of the distance from the measuring point. Multiple recording systems are available that will produce coordinated records of flow, temperature, pressure, vacuum, per cent CO_2 and other elements of operation on a single evenly divided strip chart, thereby showing at a glance the operating conditions.

There is a decided tendency toward the use of metering systems by which records of operation can be had at remote points, new systems of this kind being announced during the year. One of these will transmit records of quantities, pressure, flow, temperature, position and other elements over telephone lines being used for communication purposes without interference to either operation.

A development that stands out because of its potential value to power generation is a group of electrical instruments by which complete data on the operating characteristics of rotating machines can be made audible or visible to an operator remote from the machines under observation.

AIR CONDITIONING

BROADENS FIELD IN OFFICES, STORES AND RESTAURANTS

THE past year has seen an intense activity in the air conditioning of small commercial establishments, such as restaurants, candy stores, barber and beauty shops, private offices, and the better class of residences. This activity, preceded by the development of air conditioning units suitable for these applications, has resulted in making the general public "comfort-minded." The effort to sell air conditioning has received the backing of many of the electric utilities who see in the movement a new means of building up central station load. An increasing number of office buildings are installing air conditioning in an effort to draw tenants from those buildings not so equipped.

Refrigerating engineers throughout the country have awakened to the fact that where complete air conditioning or room cooling equipment is installed, refrigeration machinery forms a considerable portion of the installation. Their newly awakened interest in air conditioning is evidenced by the development of small refrigeration units designed particularly for air conditioning by many of the large refrigeration machinery manufacturers. Interest in the air conditioning of small establishments has resulted in such large organizations as the General Electric Co. and the Westinghouse Electric & Mfg. Co. organizing commercial air conditioning departments.

The special activity in air conditioning where small unit equipment is used has not decreased the interest in air conditioning of large auditoriums and office buildings where the central system is most economical. During the year the largest air conditioning undertaking ever attempted has been under construction, and part of it has been placed in operation. This installation is in the buildings of the new Radio City in New York. Air conditioning is to be provided for the various theatres, the broadcasting studios and the lower floors of the new 69-story R.C.A. Building. It is reported that 1,500 tons of refrigeration are to be installed for this enterprise.

An outstanding air conditioning project that is now under construction is that in the Department of Justice building at Washington, D. C. This building is seven stories high, will contain approximately 1,500 rooms and will be air conditioned throughout. It is expected that nearly 3,000 people will occupy the completed structure, and that 2,000 tons of refrigeration will be required to air condition it during the summer. Another Government project in Washington is the U. S. Post Office Building. Eight floors of this building, together with the cafeteria in the basement, will be air conditioned for year-round comfort.

Conditioned Air Plays Its Part in

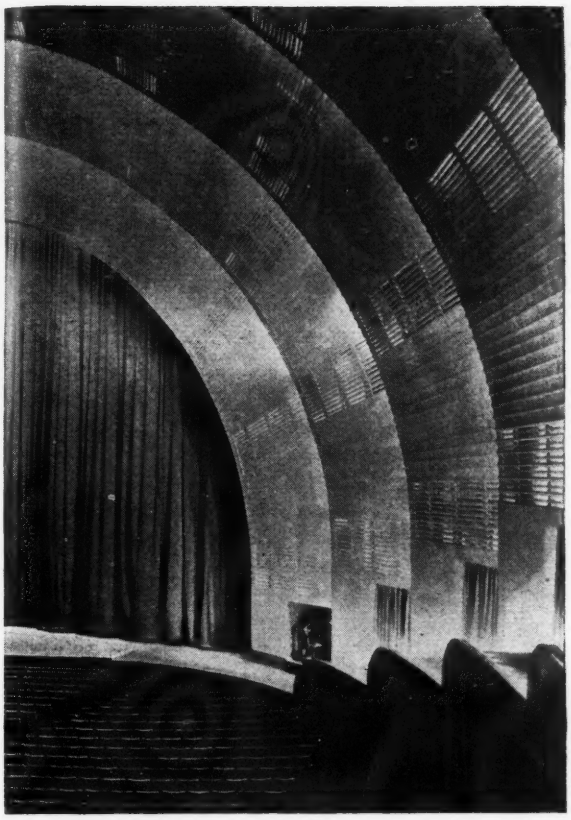
The economic possibilities of ice for air conditioning under certain definite conditions are being more generally recognized. The Detroit Edison Co., together with other agencies, reported data obtained during the past summer from establishments where ice was used for air conditioning. This data indicated that the cost of operating such installations varied between 2.2 to 4 cents per hour, per thousand cubic feet of conditioned volume, depending upon the heat load in the space to be conditioned. These costs include the cost of ice and electricity.

Renewed interest is being taken in vacuum refrigeration with water as the refrigerant, because of its special adaptability to air conditioning requirements. It provides an extremely flexible source of refrigeration, and little moving machinery is required. Although its special field of application is in the air conditioning of railroad Pullman cars, a considerable number of installations have been made in restaurant and industrial establishments.

No radical changes have taken place in the field of direct heating. Improvements in the design details of heating system control equipment have been made during the past year. This is particularly true of equipment designed to control zoned orifice systems.

A new vacuum pump developed during the year incorporates both a steam turbine and a motor-driven pump. The turbine takes steam from the main heating line and exhausts it back to the heating system operating on a $2\frac{1}{2}$-lb. pressure drop. With this arrangement the capacity of both pumps can be utilized under peak-load conditions, the electrically-operated unit cutting in whenever the steam supply is insufficient to operate the turbine.

The hot-water heating system for the new 67-story



the new Radio City Music Hall

Cities Service Building in New York City has been placed in operation. This is believed to be the first application of this method of heating to a skyscraper. To limit the pressure on the lower radiators in the building, and also to provide for greater flexibility of control, the heating system was divided into five zones, each zone not more than 15 stories high. All hot-water heaters and circulating pumps are located in the cellar for convenience of control. Each heating zone is provided with a turbine-driven water circulating pump and a steam hot-water heater. The calculated hot-water load requirements for zero weather, at 30-deg. water temperature difference, is about 3,600 gal. per min.

One new district heating plant went into operation, serving a portion of Duluth, Minn. This plant of the Duluth Steam Corporation contains four boilers, each having a maximum steaming capacity of 90,000 lb. per hour. The boilers have been designed for 425-lb. pressure, but are now operating at 200 lb.

A large central heating plant is being erected by the Federal Government to serve the "triangle" group of buildings in Washington, D. C. There are 22 new buildings being erected in this group. Six large stoker-fired boilers, having a maximum steaming capacity of 237,000 lb. per hour, are being installed. As at the Duluth plant the boilers are designed for 400 lb. pressure, but will be operated at 200 lb.

Spinning Boiler Correction

ATTENTION is called to an error in the article "New Boiler Spins at Turbine Speed" in the November number of *Power*. In the last paragraph of page 224 and also in the caption of Fig. 6, the boiler output is given as 4,000 lb. per hour. This should be 40,000 lb.

REFRIGERATION

ACCELERATED BY AIR CONDITIONING

THE refrigeration industry during the past year has shown greater interest in new applications and new methods than in previous years.

Small units complete in themselves and automatic in operation have been developed to supply conditioned air to small establishments, residences and offices where engineering attention is not practicable.

Special interest has centered around the use of vacuum refrigeration for both air conditioning and industrial applications. Steam jets are usually used to produce the required vacuum. The moderate temperatures needed, together with the ease with which varying loads may be met, make vacuum refrigeration with water as the refrigerant of particular value in the air conditioning field wherever steam and cooling water are available. It does, however, require a somewhat greater amount of cooling water than compression systems.

This system is also of potential value in food industries where a combination of evaporation and cooling is required and has been applied to the cooling and evaporation of tomato juice.

To offset the decreasing demand for ice, considerable work has been done by ice companies in developing the use of ice for air conditioning. Ice for this use is generally obtainable at $3 to $5 per ton, depending on the distance the ice has to be hauled. In applications where the load factor on the refrigerating unit is poor, ice for air conditioning is being found economical.

An unusually large installation of refrigerating equipment was placed in operation at the new Radio City in New York. This installation when complete will have a total capacity of 1,500 tons of refrigeration.

The Federal Government has placed orders for refrigerating equipment having a total capacity of 2,000 tons for the new Department of Justice building and 1,450 tons for the new Post Office building in Washington, D. C. The new refrigerant Freon is to be used in both of these installations, the first of which is reported as the largest single installation of refrigerating equipment ever made in this country.

The effort to produce portable quick freezing units has resulted in the development of a multiplate freezer. Packaged food is placed between hollow aluminum plates through which brine or ammonia is circulated. Temperatures of —35 to —40 deg. F. are used, and the whole unit including compressor is portable.

There has been an increasing use of rotary compressors as boosters in low-temperature refrigeration. These units are also being used to some extent as the main compressors.

Of the various methods employed to produce the low temperatures used in the quick freezing of foods the split-stage system is attracting considerable attention. This system uses a combination of CO_2 and ammonia, the ammonia refrigeration being used to condense the CO_2 refrigerant.

PUMP DESIGNS

PRESENT MANY ADVANCES IN 1932

PUMP developments during the last year have been characterized by a wide variety of activities. The field of centrifugal-pump applications has been extended to higher heads, thus still further encroaching upon that field generally requiring reciprocating types. In the low-head field, turbine-type pumps have made advances. Sizes and capacities of pumps have been increased. Pumping units for outdoor operation have been developed. There is a decided tendency toward electrifying municipal stations and making the control of these plants fully automatic.

Because of its size, the proposed water system for the Metropolitan Water District in Southern California is the most outstanding project. Ultimately, pumping capacity will be required on the project to pump more than one billion gallons per day from the Colorado River and deliver it into the water system 250 miles away.

There will be five pumping plants with a combined static head of 1,603 ft. Each pumping unit will have a capacity of over 125,000,000 g.p.d., there being planned nine units for each station. From 3,560 to 7,950 hp. will be required to drive each pump, depending upon its head. The motors installed in each plant will have a combined capacity of from 32,000 to 98,000 hp., and the total capacity of the five plants when completed will be nearly 400,000 hp. About 50 per cent of the total equipment will be installed in the initial development.

Many pumped storage hydro-electric plants have been installed in Europe, but so far only one has been put into operation in this country, and a second is being constructed. Such plants require very large pumps; some of those in Europe take over 30,000 hp. to drive a single unit. In the plant of the Lamoka Power Corporation in New York State there will be two 8,000- and three 16,000-g.p.m. pumps to operate against a head of 400 ft. The two small pumps will be driven by 1,000-hp. motors and the large pumps will have 2,000-hp. motors.

Interest is increasing in this type of plant in this country, and there are prospects that several will be built when business conditions become a little more reassuring. Looking toward this end, considerable attention is being given to the development of hydraulic units that will operate either as turbines or pumps.

One power company reported during the year the results of experiments with a single-stage, 125-hp. circulating pump operated on dual service. A turbine and pump efficiency of about 68 per cent was obtained at equal speeds. A turbine efficiency of about 78 per cent at a speed of 17 per cent below and a pump efficiency of the same value was obtained at a speed 12 per cent above the equal efficiency speed.

It is recognized that to obtain the best efficiency from such a unit the pumping operation must be at a considerably higher speed than when generating power. One manufacturer has developed a pump-turbine unit, an experimental model of which gave a pump efficiency of 85.5 and 89.3 per cent as a turbine.

In steam-plant pumps, those installed on units Nos. 7 and 8 condensers in circulating-water service, in the Hudson Avenue plant of the Brooklyn Edison Company, are among the largest of their kind ever installed. On each condenser are two single-stage, double-suction circulating pumps driven by 600-hp. two-speed motors. At high speed each pump has a capacity of 73,000 g.p.m. against a total dynamic head of 24 ft., and at low speed their capacity is approximately 48,500 g.p.m.

Considerable progress has been reported in the development of high-head centrifugal pumps. For oil-refining service hot-oil charging pumps have been built for heads up to 4,800 ft. in a single casing and for 7,200-ft. heads in two casings, an efficiency of 70 per cent being obtained. Another manufacturer reports a line of pumps developed for a similar service for heads up to 3,500 ft., capacities up to 800 g.p.m. and temperatures of 750 deg. F. These pumps operate at 3,600 r.p.m.

Several lines of centrifugal pumps for various services have been announced that operate at 3,600 r.p.m., which is the maximum speed obtainable with induction or synchronous motors of standard design on a 60-cycle circuit. These developments offer many advantages over some of the slower-speed types. The pumping units for a given capacity occupy less space, and induction motors for that speed have high efficiency and power factor. Single-stage, 3,600-r.p.m. pumps are available that will develop heads in excess of 650 ft.

An interesting high-head pumping installation is that in the Grand Canyon, Colo., where two 17-stage vertical centrifugal pumps operated in series deliver 90 g.p.m. against a 3,400-ft. head, from the bottom to the top of the canyon. In another installation a centrifugal pump operating against 1,200-ft. head delivers 30 g.p.m. This pump operates at 6,000 r.p.m. and is driven by a motor through speed-increasing gears. The efficiency of the two 90-g.p.m. pumps in series was 65 per cent and for the latter 60 per cent.

A rotary positive-displacement pump of a new design has been developed. This pump differs from the usual helical-gear design in that the power rotor has a convex tooth contour, which fits the concave contour of the idling rotors. The tooth contour shape provides an almost fluid-tight closure between rotors. These pumps are designed for high-speed operation and for pressures up to 400 lb. per sq.in.

Notwithstanding the encroachment of centrifugal and

Pumping plant proposed that will require 400,000 hp. Units in operation that will handle 325 million gallons per day. Centrifugal pumps operated on heads up to 7,200 ft., and rotary positive-displacement pumps for 400 lb. per sq.in. These are some of the milestones in 1932 pump history

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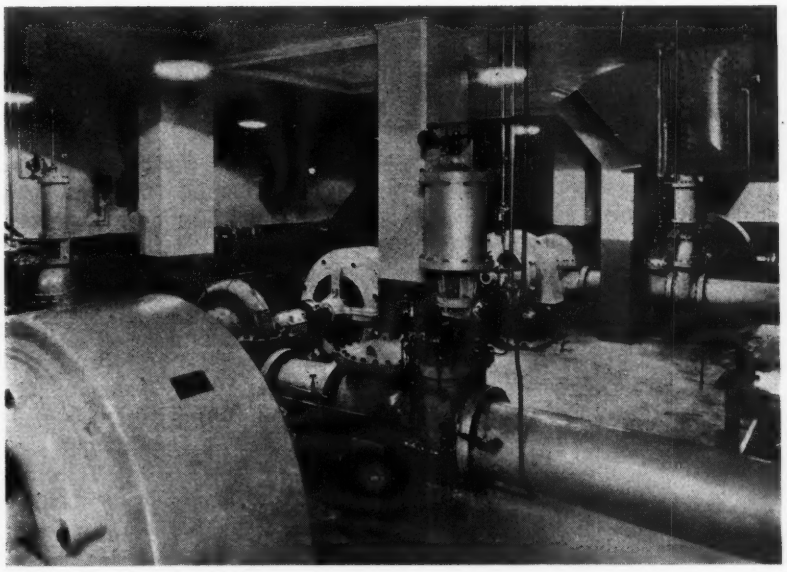
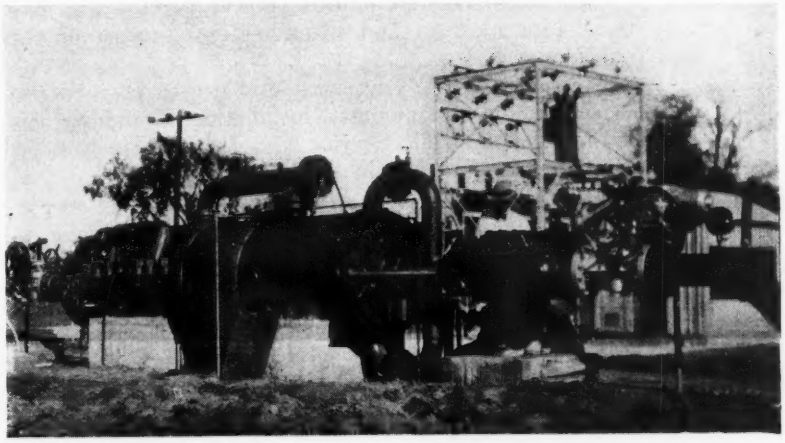




Top—The new 50-m.g.d. Guilford plant in Baltimore is one of the largest full-automatic pumping stations in operation. Below—Outdoor-type 1,000-g.p.m., 8-stage gasoline pump is driven at 3,000 r.p.m. by a 700-hp. gasoline-cooled induction motor.

other rotating types into the plunger-pump field, the latter continues to find a large field of application. During the last twelve months one large manufacturer announced complete redesign of his entire line of steam-driven plunger pumps.

Development continues in motor pumps, consisting of a motor and pump built as a single unit. Several manufacturers announced a new line of this type and in sizes up to 800 g.p.m. against a 140-ft. head. The pump and motor are assembled as a single unit with a common shaft, thus producing a compact, light-weight unit that requires no baseplate.

In the low-head field, development of propeller- and screw-type pumps has continued with several new lines being brought out during the year. They have been designed for horizontal and for vertical operation. Some of these pumps are built for very large capacities. A 48-in. propeller-type pump installed in the Robert Morrison pumping plant, Cutoff, La., operates against a total dynamic head of 9.8 ft. and discharges 52,400 g.p.m. This pump is driven at 300 r.p.m. by a 180-hp. diesel engine and tested 78 per cent efficiency.

In the Lenox pumping station, New Orleans, La., two motor-driven screw pumps operate under a 7-ft. head and each delivers 180,000 g.p.m. These pumps are especially designed to handle large quantities of water. Each pump has a 110-in. diameter impeller carried on a 9-in. shaft, which is supported in a water-lubricated rubber bearing 33 in. long.

Another low-head installation of unusual interest is that containing four 225,000-g.p.m., 27-ft. head storm-water pumps in the Connors Creek station of the city of Detroit. These pumps are of the vertical type, driven by 2,300-hp. motors, and have a syphon-type discharge.

Probably the most novel pumping unit announced during the year is one that is motor driven and designed for outdoor operation. It is on the gasoline pipe line of the Great Lakes Pipe Line Company at Paradise, Mo. The 700-hp. motor is totally inclosed with a double-walled stator frame through which the gasoline going to the pump circulates to cool the motor. The pump has eight stages and is designed for 1,000 g.p.m. against a 2,520-ft. head of gasoline.

There is a decided trend toward making municipal waterworks pumping stations either full automatic or remotely controlled. The new 50-m.g.d. Guilford station in Baltimore is one of the largest full-automatic water pumping plants that has been put into operation.

The impulse for starting a pump is given by a clock. When a pump goes into service it continues to run until the reservoir is within 3 in. of being full. A valve controlling the flow of water into the reservoir is then closed automatically, which produces a small rise in pressure that causes a relay to make contact to initiate shutting down of the pump. When the pump is shut down the timing clock comes into operation, and after the end of a predetermined interval a contact is made to put the pump back into service.

MERCURY PLANTS NEAR COMPLETION

THE year has been notable for progress in the design and construction of mercury-steam power plants. After some years of semi-commercial experimentation in plants of the Hartford (Conn.) Electric Light Co., the General Electric Co. started in 1931 to construct a $3,700,000 mercury steam plant at Schenectady to supply process steam to the General Electric Works and electricity jointly to the works and to the lines of the New York Power & Light Co.

Under the actual operating arrangement, the General Electric Co. will build and own the plant, leasing it to the utility. The utility will sell steam and electricity to General Electric as required, and will deliver to its own lines any excess power produced from the steam demand.

By the end of 1932 construction of this plant was well advanced. Initial operation in the spring or summer of this year is expected.

Saturated mercury vapor, generated at 125 lb. and 958 deg. F. will be expanded to 28-in. vacuum through a double-flow 20,000-kw. turbine. Unlike the Hartford unit, this turbine will have bearings at both ends. Mercury vapor admitted at the center will flow in both directions and will put the shaft seals under vacuum.

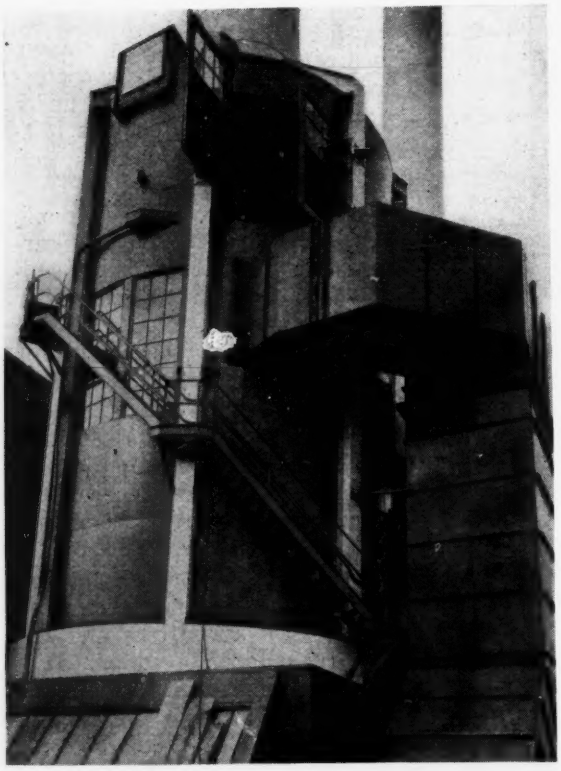
The mercury-condenser steam-boiler will generate steam at approximately 400 lb. per sq.in. pressure. This will be superheated to 760 deg. and expanded through a 6,000-kw. outdoor steam turbine to 250 lb. pressure before delivery to the G.E. process lines. Condensed mercury will be returned to the boiler by a feed pump.

With full load on the mercury turbine, 300,000 lb. of steam per hour will be produced in the condenser boiler. An additional capacity of 300,000 lb. per hour will be provided in a steam boiler.

The Schenectady plant is unusual in many other respects. It is the first outdoor power plant. The two stacks (for mercury and steam boilers) are set on the coal silos.

By the end of the year considerable progress had also been made on the mercury installation at the Kearny Station of the Public Service (N. J.) Electric Light & Gas Co. Mercury will here be used to serve as a "top" on an old steam station. Mercury vapor will be generated at 125 lb. pressure and 958 deg. F., as at Schenectady. It will expand through a 20,000-kw. turbine to 28-in. vacuum, and, in condensing, will produce steam at 365 lb. pressure. This superheated to 750 deg., will combine with steam generated by the low-pressure boilers.

Drums for the new mercury boilers are sealed up in nitrogen gas at the factory, shipped to the job and not unsealed until they are piped and filled with mercury. Tubes are calorized and heat-treated.



Top—At Schenectady, a duct carries gases to stack on coal silo. Open door shows fan rooms. Left—One of seven arc-welded unit sections for the Schenectady mercury boiler

TRANSATLANTIC TRENDS

British Superstations . . . Spinning Boiler . . . One-Tube Boiler . . . Pressure-Furnace Boiler . . . Hydrogen Engine . . . Loeffler Boiler . . . Steam in Japan . . . Hydro Records for Head and Capacity

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IN EUROPE, as in the United States, the art of power generation has made great strides during 1932. There, as here, the progress lies not in the volume of plant construction, which is small, but in the development of new and better equipment and in improved coordination of power elements.

The European progress of power is particularly notable for brilliant sallies into new fields, for the invention of radically new types of power equipment and the further development of radical inventions of previous years.

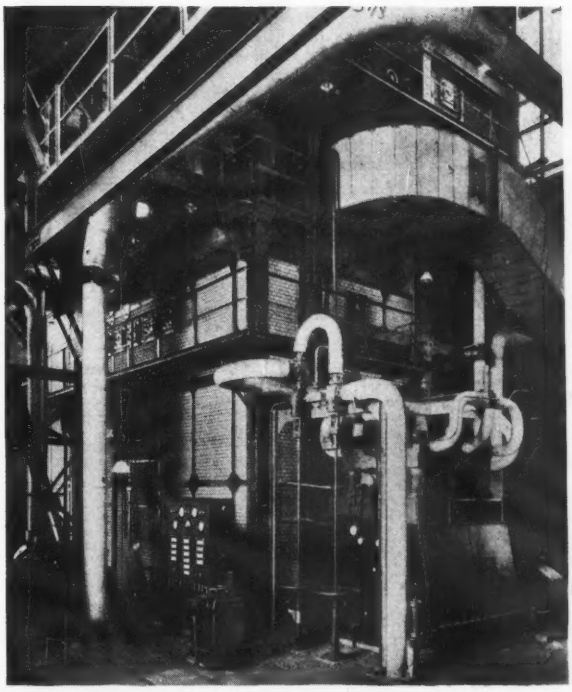
The following summary is made possible through the active cooperation of correspondents in the various countries surveyed. Material is in hand for a dozen pages. That selected for use here is concentrated largely on those designs and practices which may bring practical ideas to American power engineers.

A letter from Metropolitan Vickers reports that in England, as in other countries, 1932 was a quiet year. For central station steam conditons, 350 lb. and 750 deg. F. have become fairly standard but several of the new super-power stations have adopted pressures between 625 and 675 lb., with temperatures between 800 and 850 deg. F. Reheating has made little headway. Electrically-driven auxiliaries for power plants are now becoming general for large plants. In the case of small units, the self-contained design, which originated in Great Britain, is now fairly standard. With such plants a circulating pump and extraction pump are mechanically driven from the main turbine.

Two trends are notable: that toward centralization of central electrical generation in very large units for general distribution, and the greater use of bleeder and back-pressure turbines in industries requiring steam.

The Engineer (London, Dec. 2) reported that the first section of the great Battersea generating station of the London Power Co., is nearing completion—ultimate capacity 450,000 kw. Present equipment includes two turbines and six steam generating units. Each of the latter has a maximum capacity of 330,000 lb. of steam per hour at 650-lb. pressure and 875 to 900 deg. F. Solid forged drums are used. The boilers are equipped with economizers and tubular air heaters, forced and induced draft fans. Hydraulic ash sluicing is used. The units are fired with underfeed stokers, and the furnaces have refractory-covered water-walls.

The first central-power-station application of a steam accumulator in the British Isles was made during the year at the Pigeon House power station in Dublin, which acts as a standby to the hydraulic station at Shannon. Several industrial installations of accumulators were made in Great Britain.



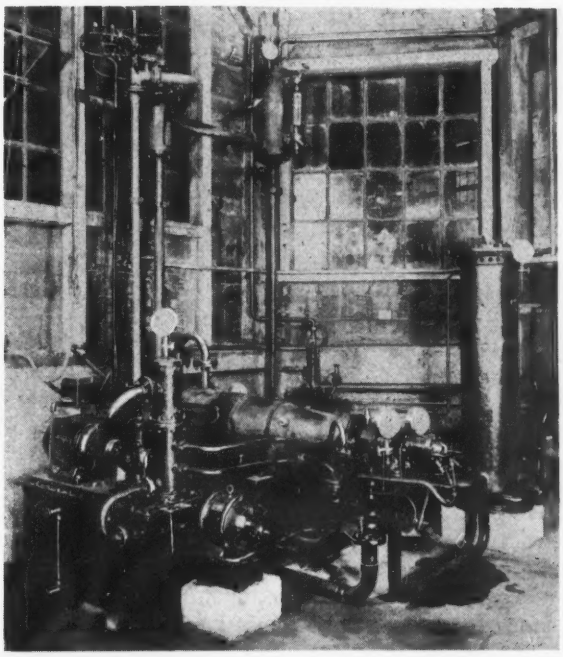


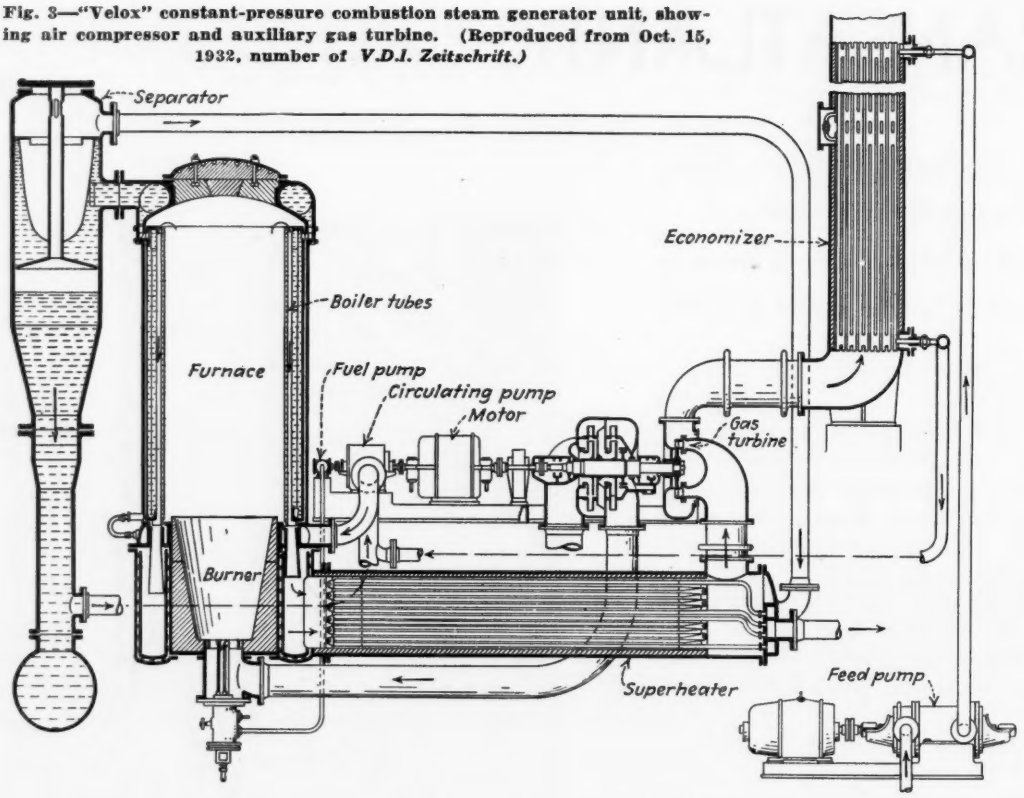
Fig. 1 (Top)—Loeffler Steam generator at the Caroline Mines plant—capacity 60-75 tons steam per hour at 1,900 lb. and 932 deg. F. Six-plunger feed pump in right foreground. Steam circulating pump in left background.

Fig. 2—Small experimental gas-fired Velox steam generator of the explosion type

An accumulator was installed in the Pretoria Steel Works, Union of South Africa, to supply three 5,000-kv. turbines. The load in the station varies with extreme rapidity from 1,000 to 10,000 kw.

In Germany Siemens-Schuckertwerke has completed

Fig. 3—"Velox" constant-pressure combustion steam generator unit, showing air compressor and auxiliary gas turbine. (Reproduced from Oct. 15, 1932, number of *V.D.I. Zeitschrift.*)



the largest single-shaft 3,000-r.p.m. turbine yet built (*Power,* May 17, 1932). It is an 80,000-kva. machine operated with steam at 500 lb. pressure and 840 deg. F. The speed of 3,000 r.p.m., corresponding to 50-cycle operation, represents a great saving in weight, space and cost over a 1,500-r.p.m. machine.

A special *Power* correspondent in Germany reports that, under present conditions, the boiler cost of a high-pressure condensing power station is about 5 to 10 per cent higher than the similar cost for a medium-pressure plant of the same kilowatt output. Such special boilers as the Schmidt-Hartmann, Loeffler, and Benson, are widely used. For reheating, German engineers prefer live steam to furnace gases.

After more than two years of operation, the high-pressure plant of the Ilse Bergbau a.g., at the Renate Mine, is clearly a success. This has three 1,400-lb. (840 deg. F.) boilers and two 12,000-kw. bleeding back-pressure turbines.

In spite of the high steam temperature and the fact that the plant is stopped and restarted every week, there have been no serious troubles with flanged joints in the steam lines. In the future the flange bolts will be made of molybdenum steel.

Because of the economic situation, no new power plants are being built in Germany, according to another correspondent. A new steel has been developed with a very high melting point and resistance to corrosion and blistering. It is understood that it will permit steam temperatures of 932 deg. F. to be used shortly.

Because of the great improvement in traveling grate stokers only a few pulverized coal installations are being made. Combustion-air temperatures up to 482 deg. F., with mechanical grates, and up to 662 deg. F., with pulverized coal are used. The under-blast chain-grate stokers are burning almost all fuels, even brown coal with 50 per cent water content.

Up to 700 lb. boiler pressure, welded drums are preferred. Riveted boiler drums are scarcely used any longer at pressures above 300 lb. In Germany, as in the United States, the trend is toward greater utilization of by-product power.

On either side of the Atlantic there has been, during the last ten years, no more sensational proposal than that made by Dr. Ing. Heinrich Vorkauf of Berlin. The November number of *Power* described his rotating boiler which is integral with the turbine shaft and spins at 3,000 r.p.m. Detailed designs have been published, but no commercial machine has actually been built. However, the spinning boiler principle has been tested out to some extent with an experimental model.

Advantages claimed are enormous reduction in heating surface, due to induced gas turbulence, elimination of feed pumps and of all high-pressure valves, glands and packing, elimination of draft fans, and the possibility of turning almost the entire power plant into a single compact machine.

American engineers will wait with interest to see what difficulties, if any, are encountered in providing adequate strength and balance in the rotating boiler, and in providing for the differential temperature stresses.

Another example of the innumerable ramifications of high-pressure boiler development in Germany is furnished by the new Sulzer single-tube boiler. This high-pressure design utilizes forced high-velocity circulation and a single tube of small bore without a drum. For a generator capable of producing 20,000 lb. of steam per hour, the single tube has a length of about 1½ miles.

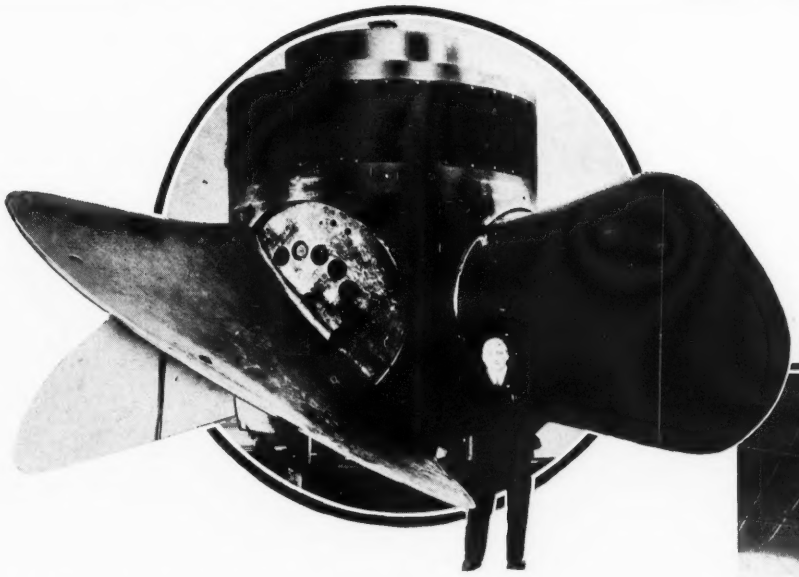
Sulzer Bros. have completed experiments with a laboratory generator, and have obtained two orders for 1,400-lb. pressure commercial boilers to generate 40,000 lb. of steam per hour and 18,000 lb. respectively.

A radical development is the hydrogen engine of the Erren Motor Co., Berlin. This company reports great success in the use of hydrogen as an internal combustion engine fuel. It is proposed that large electrolytic plants for producing hydrogen and oxygen under very high pressure be attached to hydro plants and certain steam plants, for use of excess power. The hydrogen would later be burned in Erren engines, and the oxygen sold in the general market.

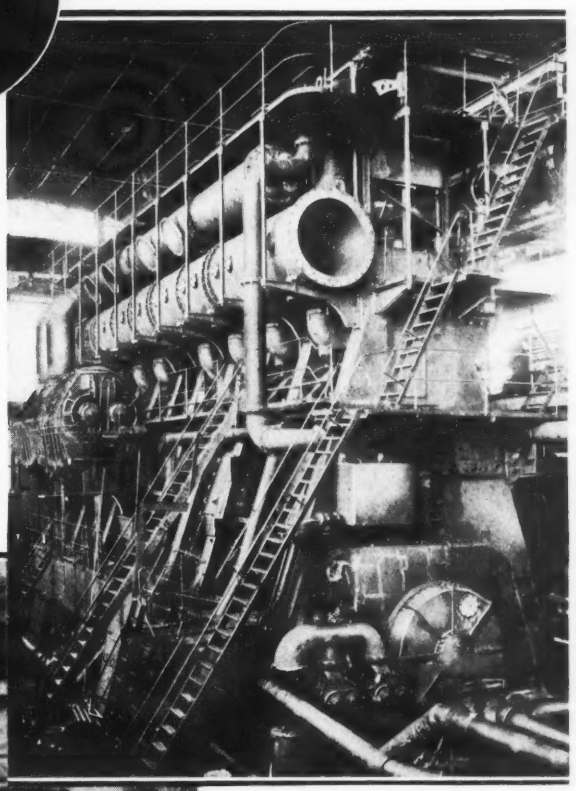
A characteristic of the hydrogen engine is that the exhaust is entirely harmless and may be discharged directly into inhabited rooms for heating and air conditioning.

(*Continued on page* 48)

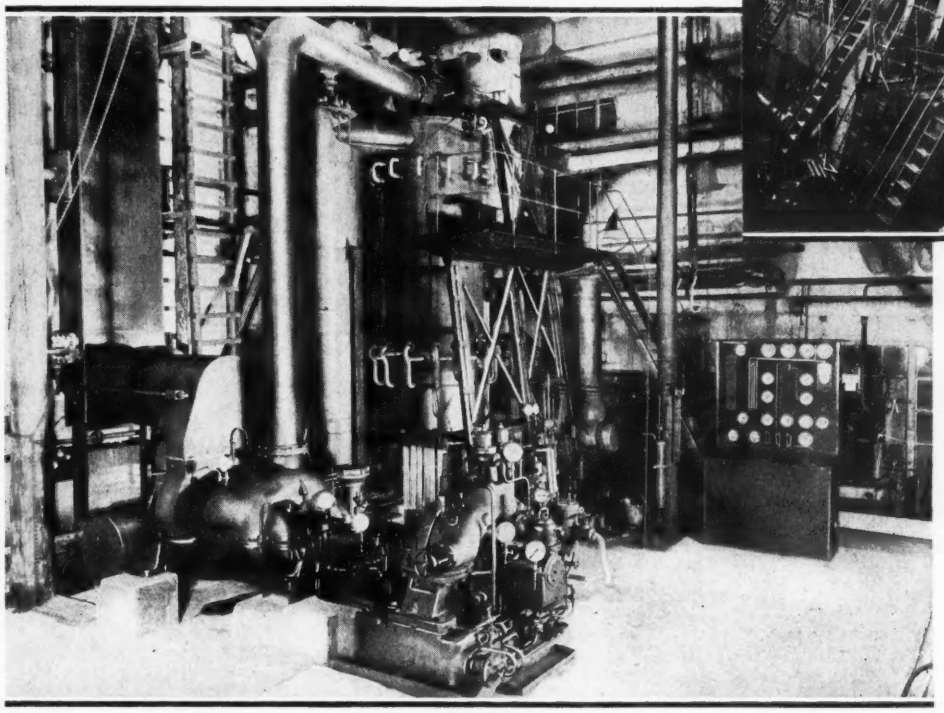
NEW POWER for the OLD WORLD



● ONE of the four 37,500-hp. Kaplan runners for the Swir III plant in Russia. They are 24.35 ft. in diameter and have stainless steel blades



● THE Velox boiler uses an exhaust turbine to compress combustion air to several atmospheres. This constant-combustion-pressure unit will generate 25,000 lb. of steam per hour



● THE world's largest diesel, the 22,500-b.hp., 8-cyl., double-acting, two-cycle, solid-injection unit for the Copenhagen (Denmark) municipal plant. Cylinder diameter is 33 in., stroke 59 in., speed 115 r.p.m.

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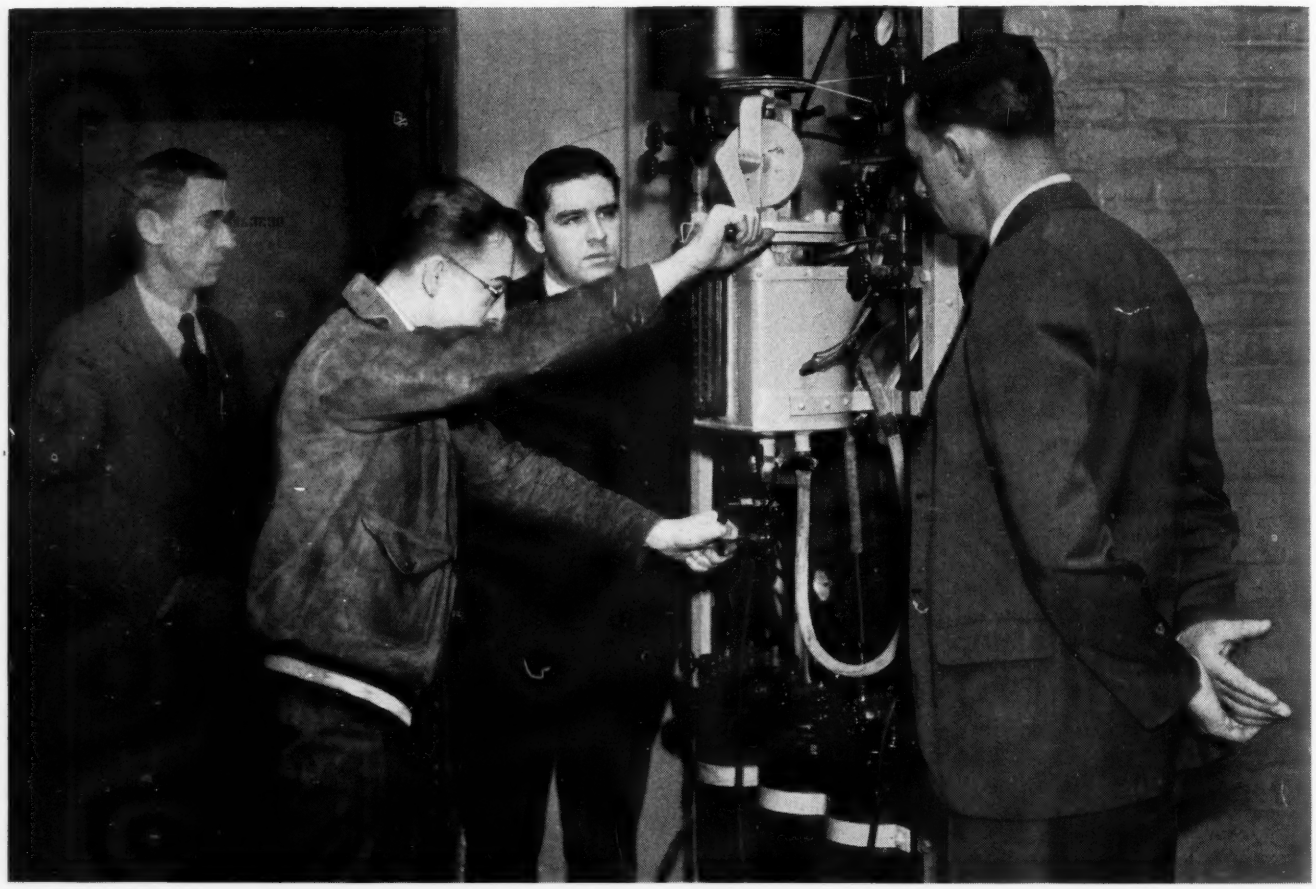
TYCOL'S GREATER

Skeptical Power Plant



RE-refining competitive oil in Tide Water's laboratory Edeleanu machine. Since the test described in this advertisement, we have arranged with Electrical Testing Laboratories, N.Y.C., to witness tests and certify results. Left to right, Electrical Testing Laboratories observer, Tide Water research chemist, Tide Water technologist, and representative of power plant operator whose oil was examined.

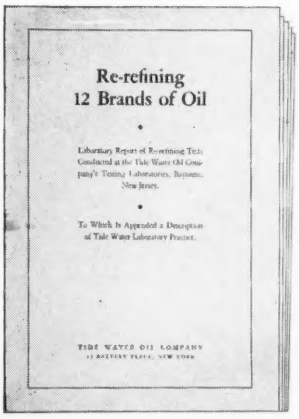
IMPORTANT DATA OF RE-REFINING TESTS

TESTS	SUBMITTED SAMPLE ORIGINAL OIL	PURIFIED OIL 93.5%	UNSTABLE EXTRACT 6.5%
Gravity	28.7	30.1	12.9
Vis. @ 100° F	624	575	—
Vis. @ 210° F	75	74.5	105
% Carbon Residue	0.90	0.68	3.89
Oxidation Number	2	0	428

STABILITY DEMONSTRATED

Operator Gets Proof

Tide Water's revolutionary process produces amazing results in RE-*refining tests on competitive turbine and Diesel oils*



Several months ago, we made this startling offer to users of turbine and Diesel oils:

"We will prove in your presence that TYCOL Oils excel all others because they are more highly, more selectively refined. Just furnish an unused sample of the oil you are now using and (before your eyes) we will RE-refine it by Tide Water's Edeleanu Process. Even though it has received the best efforts of its original refiners, we'll take out of it impurities that conventional refining can't remove."

Naturally this offer aroused tremendous interest in the lubricating world. "Give us the proof" came from all directions.

TIDE WATER MAKES GOOD ITS OFFER

Here is the proof from one of the first tests, made with a competitive oil rated as one of the highest in quality. From this oil Tide Water removed 6.5% unstable extract.

This extract had a gravity comparable with that of fuel oil. It showed 4 times as much carbon residue as the original oil and 200 times as high an oxidation number. (See chart, opposite page).

The purified oil was of increased gravity; it had a flatter temperature-viscosity curve, lower carbon residue content. Its oxidation number was cut to 0.

Here is definite proof that oils refined by Tide Water's exclusive process excel those produced by conventional refining . . . and the reason is easily understood. The process operates upon a very simple physical principle . . . solution . . . rather than upon chemical laws. It physically dissolves and extracts ALL unstable hydrocarbons. It eliminates chemical reactions which, in other methods, not only affect the impure hydrocarbons but attack and impair the pure as well.

CONVINCING SERVICE RECORDS

That is why Tycol Turbine and Diesel Oils, being 100% paraffine base, and refined by this process, have purity and stability which no other oils possess. Convincing service records bear out all these laboratory-indicated superiorities.

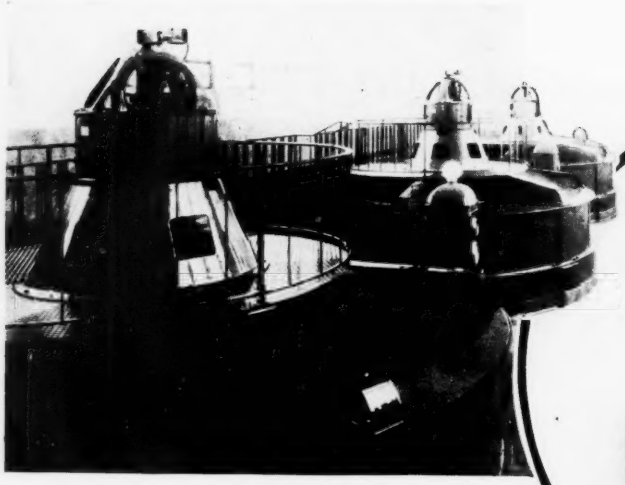
Based on these records . . . made for some of the country's leading producers of power . . . you can depend on Tycol Oils for low acidity, low carbon deposition and better demulsibility. You can depend on them for stability, for non-sludging, long-lasting, efficient, economical lubrication.

A complete description of Tide Water's Edeleanu Process and of methods used in testing competitive oils is contained in our Laboratory Report, "RE-refining 12 Brands of Oils." A copy will be mailed upon request. Tide Water Oil Sales Corporation, 17 Battery Place, New York.

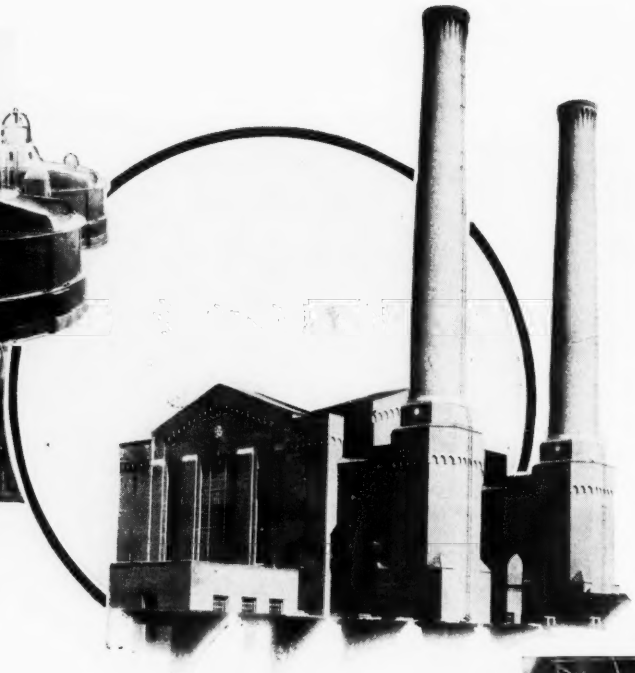
INDUSTRIAL TYCOL OILS-GREASES

TIDE WATER

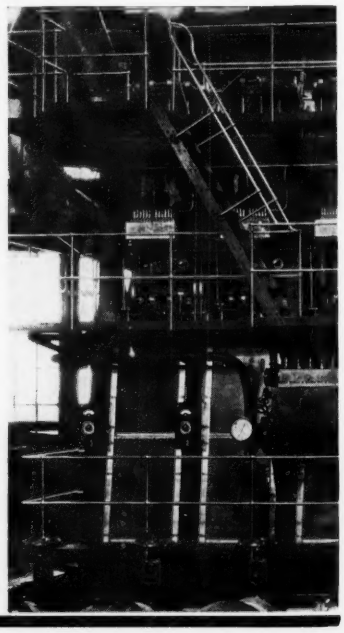
NEW POWER for

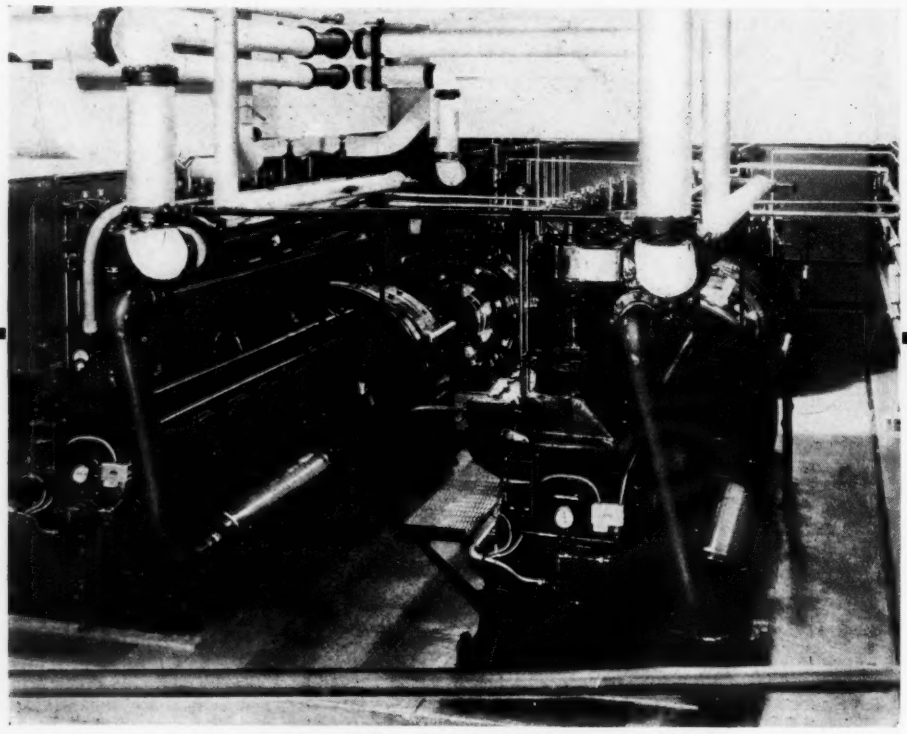


● THREE 4,500-hp. units at the Eagle Pass (Tex.) hydro-electric plant have set turbine efficiencies of 93.9 and over-all unit efficiencies of 90.7—a new high mark attained through refinement of turbine and plant design



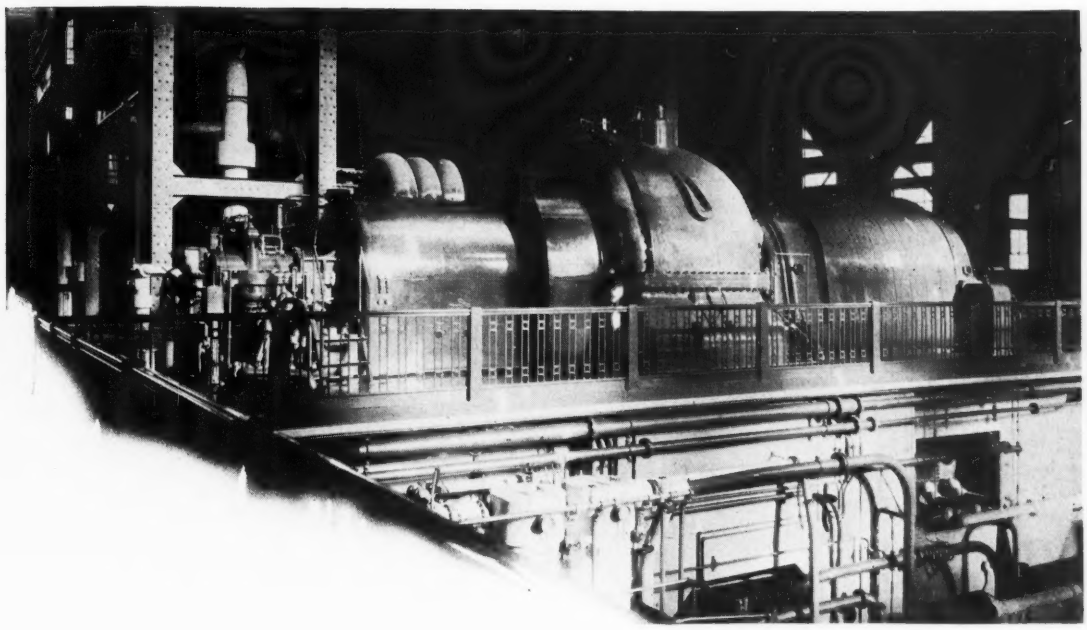
● POWER, hot and cold water and steam for heating are all provided by this 3,400-kw. power plant of Pilgrim State Hospital at Brentwood, L. I.



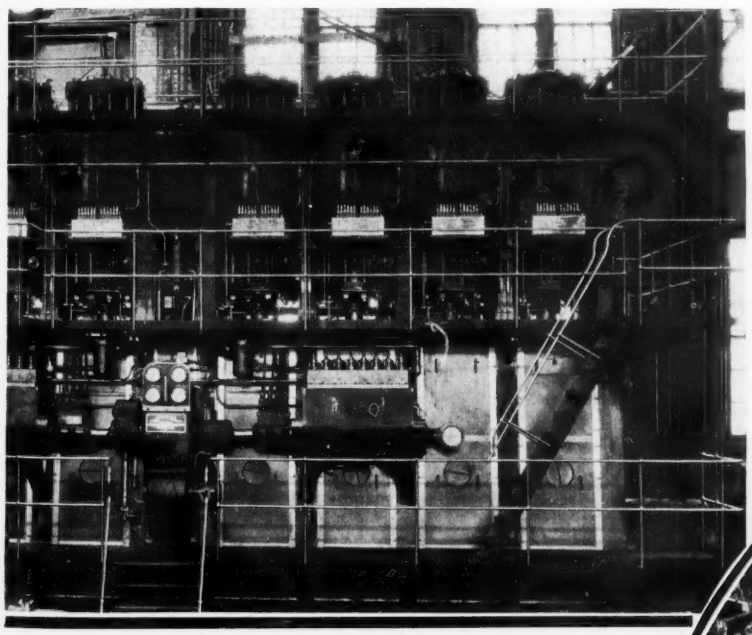


● FULL-AUTOMATIC operation is a feature of this diesel installation in the No. 1 Park Ave. Bldg., New York City. The four 270-hp., 360-r.p.m., solid-injection diesels are direct-connected to generators

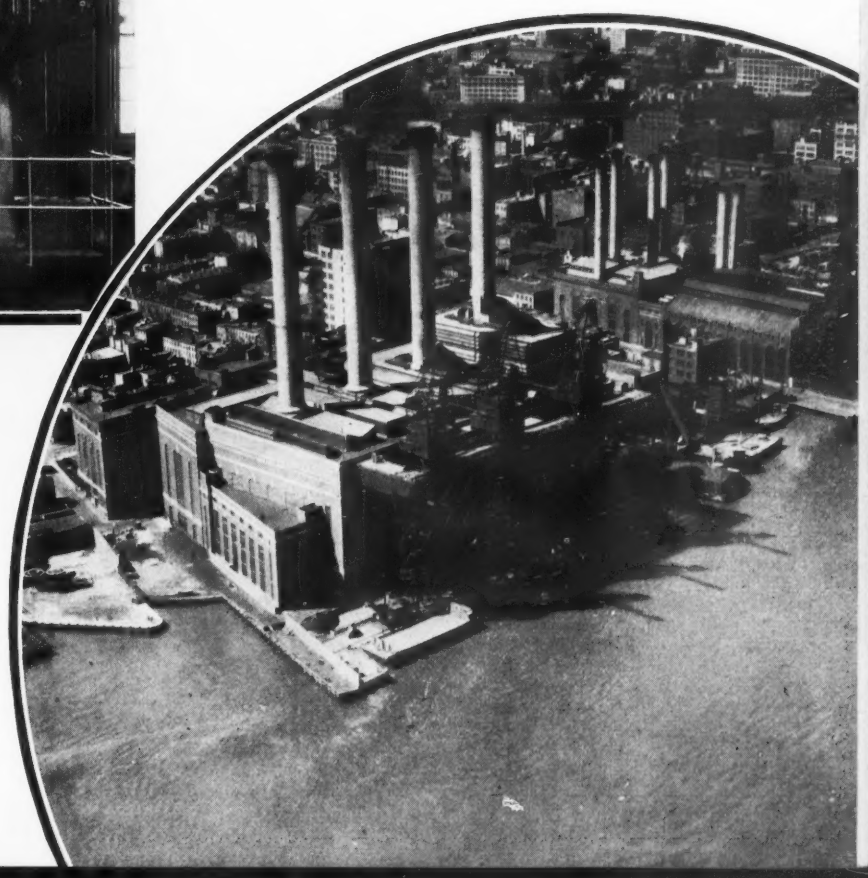
the NEW WORLD



● INTERIOR of the 30,000-kw. Edgewater plant at Sheboygan, Wis., of Wisconsin Power & Light Company



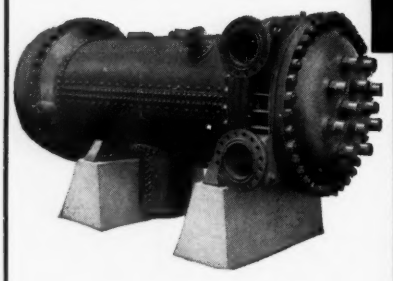
● ONE of the five 7,000-b.hp., double-acting, 2-cycle, solid-injection diesel engines now being installed at the Vernon (Calif.) municipal station



● WORLD'S largest steam power plant, created by the addition of 320,000 kw. to the Hudson Ave. Station (Brooklyn Edison Company), to make the station's total capacity 770,000

Photo Fairchild Aerial Surveys, Inc.

COCHRANE CLOSED HEATER

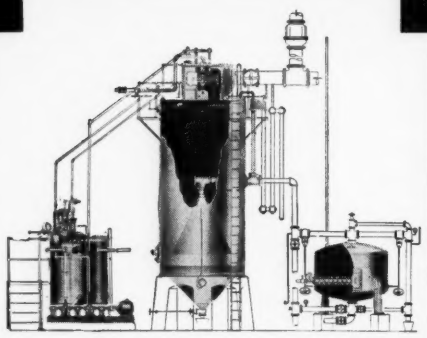


Designed for modern steam conditions

THE regenerative heating of boiler feed water by means of bled steam has required the development of a line of heaters characterized by a high rate of heat transfer, accessibility of heating surfaces and special provisions to eliminate expansion and contraction strains. Straight tubes are used, with one or more passes and fixed, floating or multiple floating heads, depending upon temperature rise and other conditions. The tubes are accessible upon removing the water box and floating head covers. Through bolts secure the outside flanges and covers. Cast iron, cast steel and steel plate shells are supplied.

● Ask for Bulletin L-688.

COCHRANE HOT PROCESS SOFTENER

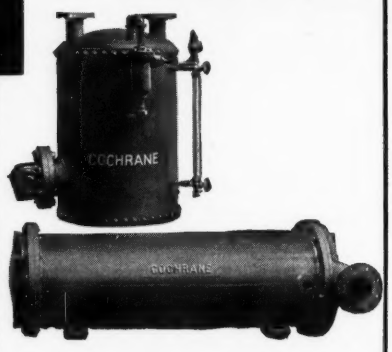


Conditions water for high pressure boilers

BY modifying the water treatment according to the nature of the water supply, high pressure boilers are now operated satisfactorily on 100 per cent make up, without scale, corrosion or danger of embrittlement. The Cochrane Hot Process treatment utilizes phosphates according to the Hall patents to secure perfect softening while keeping the carbonate-sulphate ratio within the A.S.M.E. Boiler Code requirements to avoid embrittlement.

● Ask for Bulletin L-689.

COCHRANE CONTINUOUS BLOW-DOWN



Saves heat and water

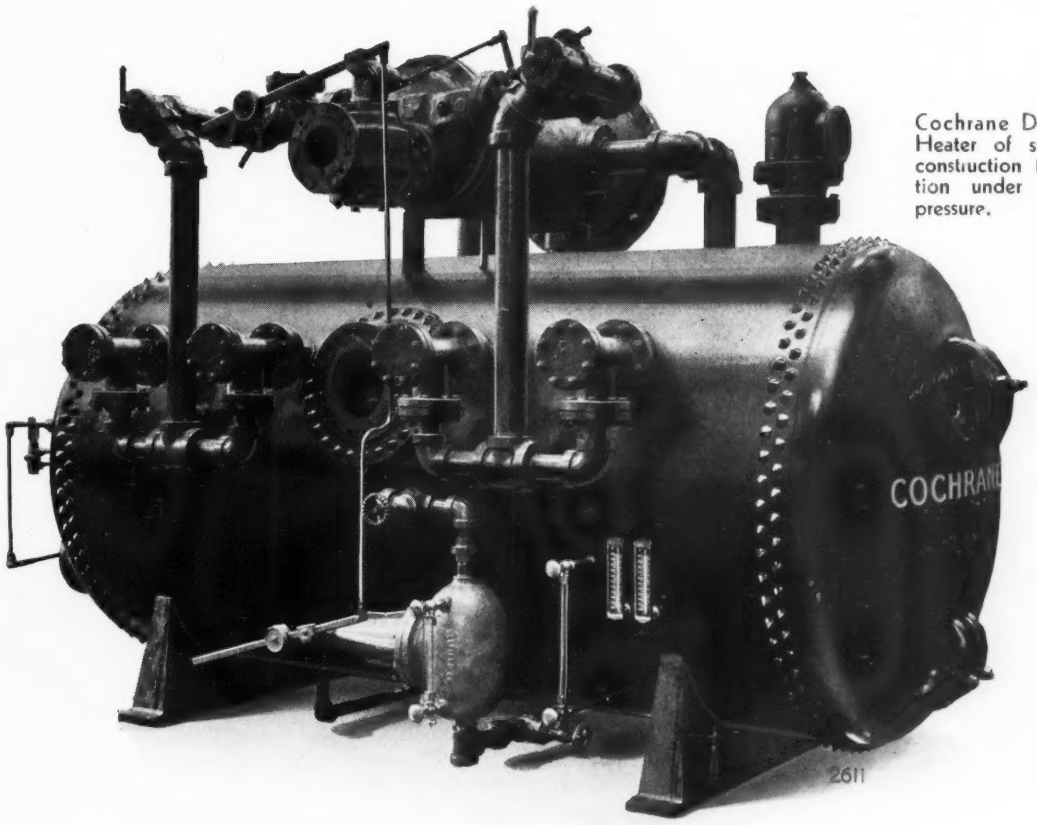
THE concentration of the boiler water is maintained constantly at the desired value by blowing off continuously a small stream from which heat is recovered in the form of flashed steam and by means of heat exchangers. The resultant savings of heat and fuel pay for the equipment in two years or less. The operation of the boilers is more simple and regular and the steam produced is more uniform in quality than where the boilers are blown down intermittently. Continuous blow down, in combination with Cochrane water softening equipment, makes operation with 100 per cent make-up practicable and economical.

● Ask for Bulletin L-683-A.

COCHRANE CORP., 17th & Clearfield Streets, PHILADELPHIA, PA.

DEAERATION
has become a necessity

BOILERS and economizers which are operated at high pressures and high ratings require an unfailing supply of properly conditioned feed water.



Cochrane Deaerating Heater of steel plate construction for operation under 150 lbs. pressure.

The COCHRANE DEAERATING HEATER

provides deaerated water, insuring against oxygen corrosion of piping, economizers, boilers and turbines.

The water is heated to the exact temperature of the steam supply, without waste of steam and regardless of the pressure carried or of variations in volume and pressure of the exhaust or bled steam.

The Cochrane Deaerating Heater can be combined with a Surge Tank or with a V-notch Meter or with a Hot Process Softener.

H-48

COCHRANE CORP., 17th & Clearfield Streets, PHILADELPHIA, PA.

CHART FOR DETERMINING AIR DENSITY

By HENRY C. OATLEY

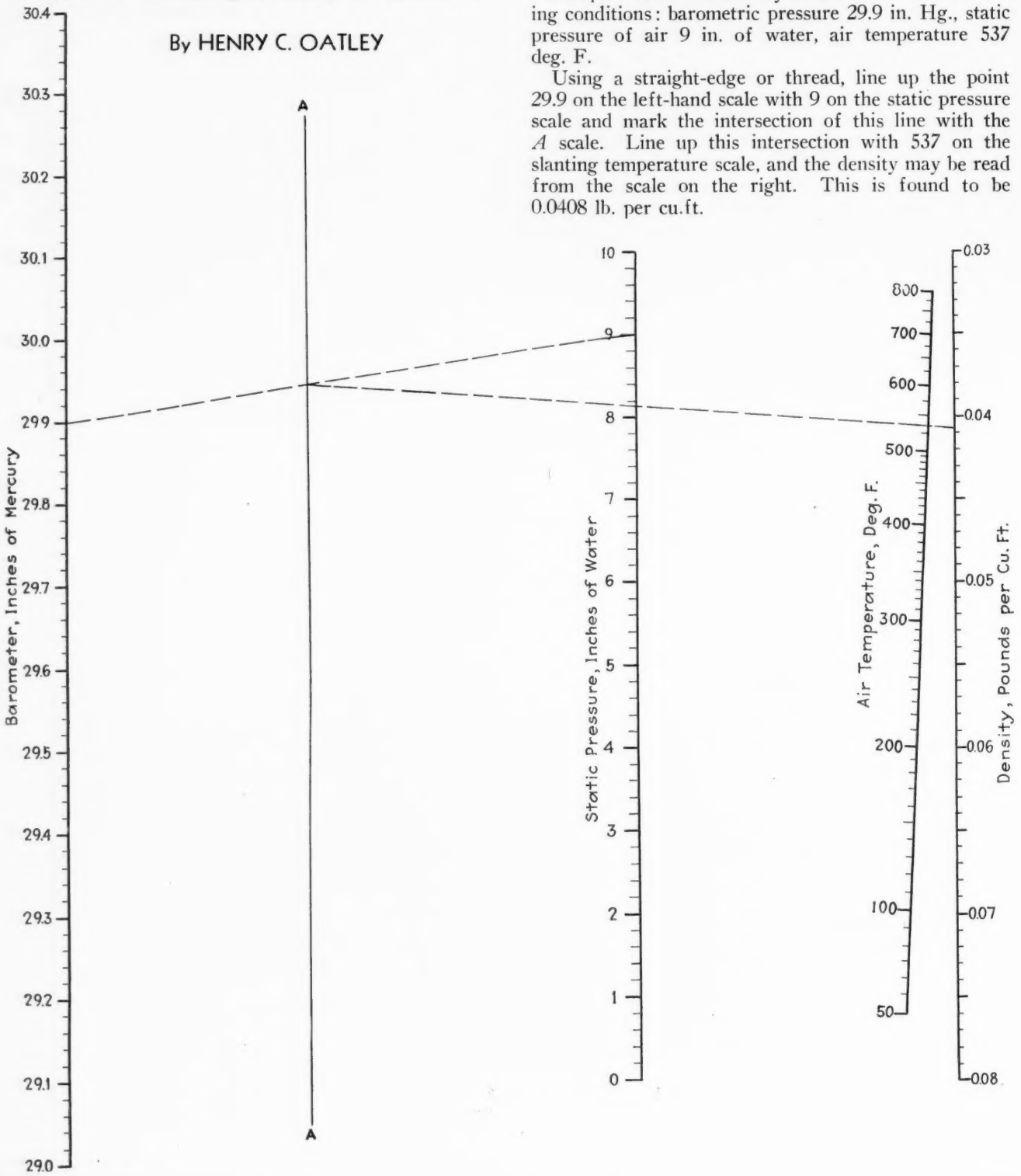
CALCULATIONS involving flow of air in ducts or pipes require the determination of air density under a wide variety of temperature and pressure conditions. The density of air varies directly with the absolute pressure and inversely with the absolute temperature. At standard conditions of 29.92 in. of mercury pressure and 492 deg. F. absolute temperature air has a density of 0.0807 lb. per cu.ft. As pressure readings for air are usually in inches of water instead of inches of mercury, the equation for calculating air density was modified to convert the observed readings to inches of mercury. The modified equation used is:

$$\frac{d_1}{1.33} = \frac{B + \frac{H}{13.6}}{T_1}$$

where d_1 = density under observed conditions, lb. per cu.ft.; B = observed barometric pressure, in. Hg.; H = observed static pressure, in. of water; T_1 = observed absolute temperature.

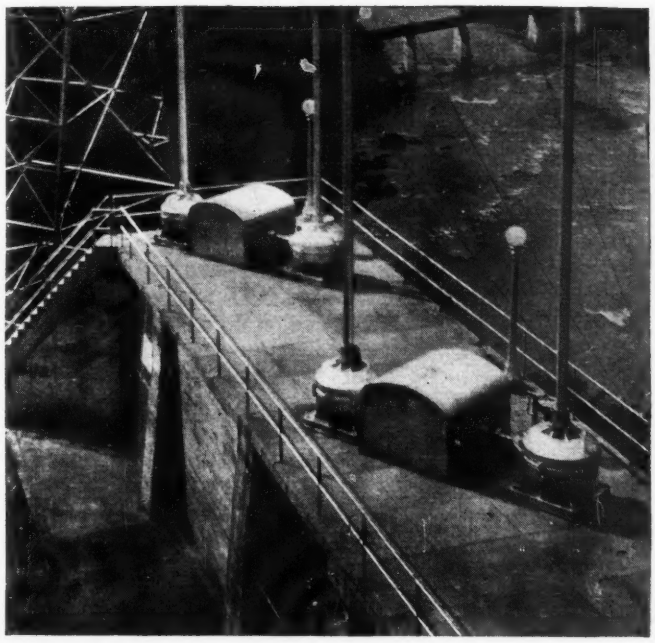
Example: Find the density of air under the following conditions: barometric pressure 29.9 in. Hg., static pressure of air 9 in. of water, air temperature 537 deg. F.

Using a straight-edge or thread, line up the point 29.9 on the left-hand scale with 9 on the static pressure scale and mark the intersection of this line with the A scale. Line up this intersection with 537 on the slanting temperature scale, and the density may be read from the scale on the right. This is found to be 0.0408 lb. per cu.ft.



©Power

PRACTICAL AIDS TO OPERATION



Insulation for Conductors in Damp Conduits

In hydro-electric plants and in certain industrial plants conduits may be run through concrete, as for penstock-valve operating mechanisms in the photograph, or buried in the floor where the temperature may remain fairly low in the conduit as compared to the air temperature. In such installations a breathing action takes place and condensation results in the conduit. Maintenance, therefore, becomes burdensome due to burnouts and grounds if the standard code rubber or varnished-cambric insulation is used.

I have found that for voltages below 500 volts, good results may be obtained with the use of 30 per cent para rubber insulation with a single braid for protection during installation. Where the cost is justified by service requirements or where the conductors may be immersed at times, a special compound insulation may be preferably used. The latter type may be used in place of varnished cambric insulation in damp locations for voltages up to 13,800 volts where the use of lead-covered cable is not suitable. J. Elmer Housley.

Alcoa, Tenn.

Voltage Regulators Failed to Operate in Parallel

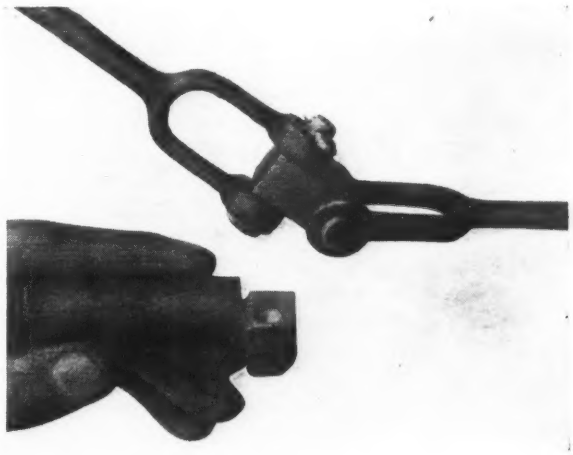
Some time ago two 25,000-kva., 13,000-volt waterwheel generators were installed and connected to a common generator bus. The excitation for these machines was isolated, there being an exciter for each machine. The regulator voltage was taken directly from each set of generator leads between the machine and the oil switch. Because of the short distance between the two machines, some form of line drop was necessary in order that each regulator work as it should. Two line-drop compensators were obtained for this part of the voltage regulation. When the two regulators were put in service it was found that operating them together was almost impossible. They were continually pulling apart, and one regulator would stop entirely. A great deal of speculation took place as to the trouble, and many tests were made which included a number of wire changes but without improving operation. It was then decided to run only one voltage regulator.

Some time later the conditions came to my attention. There appeared to be no reason for the regulators not working together. I had the operator take a series of readings of load together with the action of the regulator and its exciting current. From these data I figured that the trouble lay in the adjustment of the regulator. I then started testing the regulator's effect on the voltage and found one tending to raise the voltage as the load increased while the other lowered the voltage. The regulators were then adjusted for flat voltage from no load to full load, and they are now working in parallel satisfactorily.

Great Falls, Mont. B. W. Hamilton.

Easily Made Universal Joints for Valve Operator

A light but fairly strong universal joint is often needed in the power plant to extend the operating device of small valves, shutters and other apparatus to a point where they can be conveniently manipulated. The parts of a universal joint, when it must be a homemade one, are hard to cut out and put together. I solved this problem by taking two old automobile truck brake rods and used their non-adjustable ends as the jaws for a universal joint. For the rectangular block between the jaws, any convenient piece of metal may be commandeered. On the one shown in the figure a piece of the head of



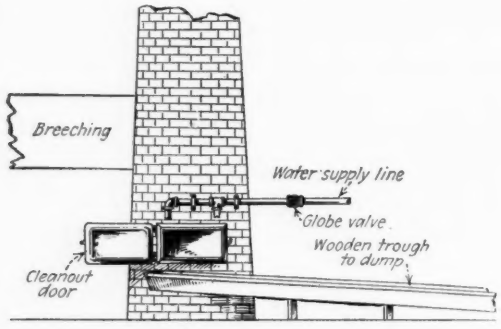
an old ¾-in. square-head bolt was drilled with holes to fit the small jaw pins.

The metal in the brake-rod jaws and rods is of good material, including the pins, and even on a junked set will generally be in good condition. Such rods are quite easy to get from any junked-car dealer, and of almost any size. From them a universal joint can be put together quite easily and quickly.

Missouri Valley, Ia. FRANK W. BENTLEY, JR.

Soot Removal from Chimney by Water Jets

SOOT removal by water from the cleanout door at the base of a chimney is not a new idea. However, shoveling soot into a wheelbarrow and wheeling it for considerable distances to a dump is still a familiar sight



around many boiler plants. This is a dirty, unhealthy and often dangerous job, especially when the hot soot is reached.

I have found the method shown in the figure simple and effective. Anchor a water line to the stack just above the cleanout door. Two nipples pointing down and tilting inwards are teed off of the horizontal line, which is of 1-in. pipe. A wooden trough 4x10 in. in cross-section slopes away from under the cleanout door to low land. At cleaning time water is turned on and it mixes with the soot, the mixture flowing down the trough. M. O. Ross.

Philadelphia, Pa.

Paralleling an A-C. Generator Without Synchronizing

ONE day in an industrial plant the engineer suddenly noticed that the power demand had crept up close to the maximum contracted for and knew that shortly the load would be increased about 100 hp. This load would increase the maximum demand beyond the contract and cause a substantial increase in power cost for the year. The cause of the increase would last for only about a week when the load would drop back to below the contracted demand. It was therefore desirable to keep the purchased power demand within the contract limit.

In the power house there was a 150-kw. alternating-current turbine-generator that supplied power before large additions were made to processes and the plant went over to purchased power. This unit had been kept in running condition to operate the pulverized-coal plant and furnaces in case the outside power supply failed. To do this it was only necessary to trip the breaker on the incoming power line and close the turbine-generator switch.

It was clear to the engineer that if the 150-kw. turbine-generator could be paralleled with the incoming power the increased load could be handled without exceeding the maximum demand. No means was available to show when the generator was in synchronism with the incoming power and the engineer did not have time to rig up temporary synchronizing lamps.

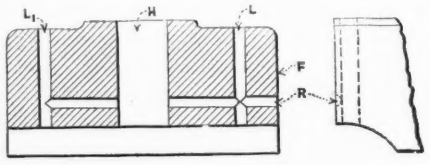
The difficulty was overcome by starting the turbine and bringing it close to full speed, without exciting current on the generator's field coils. The steam was then shut off and the switch closed, connecting the generator to the busbars, which then operated as an induction motor. Next excitation was applied to the generator field coils and the machine pulled into synchronism and operated as a synchronous motor. Then the throttle valve was opened, thus changing the equipment from a synchronous motor to a generator to carry part of the load and prevent the plant from exceeding the contract demand. GEO. P. PEARCE.

Moline, Ill.

Auxiliary Oil Duct Improves Bearing Lubrication at Starting

WHEN starting under heavy loads the main shaft on one of our pumps was noisy, vibrated excessively and would quickly run hot. Each bearing was lubricated through two sight-feed lubricators, dripping directly onto the shaft through ½-in. holes in the bearing cap. Inspection showed most of the trouble to be at the bearing face *F*, in the figure, which took the crank side thrust. This surface was normally lubricated by oil working out along the shaft from the nearer oil drip, but sometimes this flow failed and trouble started.

The difficulty was overcome by drilling a ⅜-in. hole into the bearing cap 1 in. above the shaft and parallel to it, intersecting the first oil drip tube *L*, passing through hand



hold *H*, and ending at the second oil drip tube L_1. A pint of oil, poured into the hand hole before starting the unit, will now reach both oil drips and overflow through hole *R* to lubricate the crank face.

In event of oil stoppage at the shaft in either oil-cup drip pipe, the lubricant quickly fills to the level of the hole *R* and finds its way to the shaft through the next opening.

This auxiliary oil duct makes it possible to leave the lubricator drips adjusted for most economical running. However, oil can be quickly added and distributed evenly for starting when the load is greatest, and when oil from the last run may have drained away from the shaft and left the bearing dry.

Longview, Texas. ELTON STERRETT.

Traps Replace Pumps for Handling Condensate from Paper Machines

SEVERAL machines in a large paper mill were supplied with pumps to return the condensate to a hot well in the boiler room. These pumps were small motor-driven centrifugal units, as in Fig. 1. Each pump had sufficient

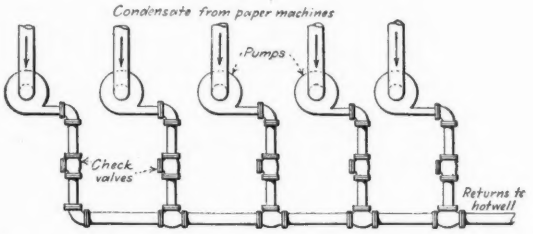


Fig. 1—Pump arrangement used to handle condensate from paper machines

capacity to take care of the condensate from one machine at maximum flow. Often the condensate would be less than the pump rating. This resulted in partially steam-bound pump operation, causing serious overheating of the pumps, frequent packing burnouts, and even breakage of the impellers due to the sudden temperature changes and shock from slugs of water that accompanied a change in condensate flow.

To overcome this difficulty the pumps were replaced by traps, piped to each machine and discharging into a

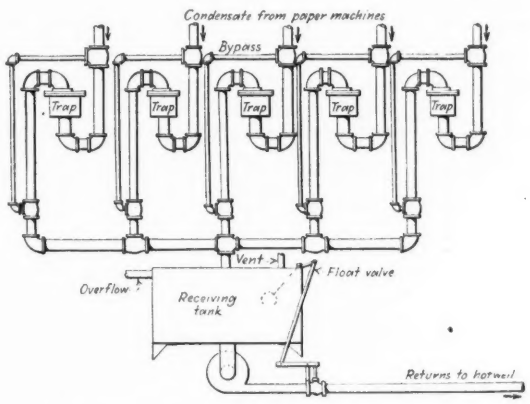


Fig. 2—Traps replaced the pumps in Fig. 1

common receiver vented to atmosphere as in Fig. 2. From here a pump discharges the condensate back into the hot well. The discharge of this pump is controlled by a float-operated valve to maintain a constant suction head.

Columbus, O. R. O. MILLS.

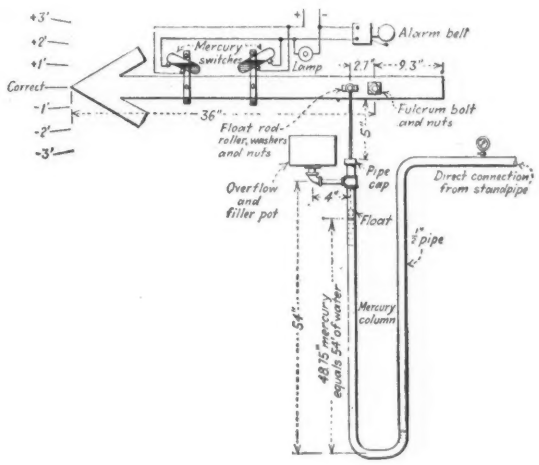
A Direct-Reading Water-Level Indicator and Alarm

MANY are the types of indicators for showing liquid level at some remote point that may be purchased or constructed by the engineer. One type, shown in the figure, is simple to construct and shows clearly some distance away. It was designed to show water level in a standpipe about a quarter of a mile from the plant. The pointer is designed to move the same distance as the water level in the standpipe, that is, if the water in the standpipe rises one foot, the indicating pointer moves up one foot also.

A $\frac{1}{2}$-in. pipe runs directly from the standpipe base to the indicator. It is important that this line come directly from the standpipe to show static pressure. The pipe is bent into a loop and is clamped onto the wall at some suitable point. An iron pot, which may be a 3-in. coupling and reducing bushing, is connected into the side of the vertical leg for a mercury overflow. Mercury is poured into the pot until a depth of 27 in. in shown from the bottom by a measuring stick. The float consists of a cork stopper with a thin metal washer on the top and bottom, the float rod being threaded for a nut above the top washer and another one under the bottom washer.

The pointer is cut from sheet steel and slotted for a sliding connection with the float rod. The dimensions between the end of the pointer and its connections will vary in each case from those given in the diagram, but the method for determining these may be as follows:

The over-all length of the pointer and distance from the pivot to the point is optional in any case and may be selected to suit. Assuming it is desired to have the



pointer move at a rate and distance corresponding to the water level: With a 55 ft. elevation in the standpipe a static pressure of $55 \times 0.434 = 23.87$ lb. or $23.87 \times 2.08 = 49.65$ in. of mercury obtains. A 54-ft. elevation is equivalent to 48.75 in. of mercury; and 53 ft. to 47.84 in. Thus at this static pressure one foot difference in elevation in the water will cause a change in pressure of 0.9 in. of mercury. If the pointer end is to move 12 in. as the water level moves 12 in., a ratio of 12 to 0.9 in. must obtain between the float rod and the point of the indicator. If the distance from the float-rod connection to the pointer to its point is 36 in. and when the point moves vertically 12 in. the float rod moves 0.9 in., then the distance from the float rod to the pointer's fulcrum is $\frac{36}{12} \times 0.9 = 2.7$ in., as indicated in the figure.

When completed and ready for assembly the tail of the pointer should be weighted so as to balance the long lever arm. This allows the float to make good contact with the surface of the mercury without submerging. Two mercury-contact tilt switches are mounted on top of the pointer, one for high and one for low levels. These are wired up in parallel to a light and a bell alarm.

Milford, N. J. HARRY M. SPRING.

CURRENT COMMENT

Fuel Pump Cams May Cause Diesel to Knock

A.F.O., in the October number of *Power,* describes his trouble with a knock in a 4-stroke cycle diesel. I had similar trouble with a 4-cyl. unit. I found my trouble to be in the fuel pump cams, which were worn, thus causing the fuel to enter too late in the stroke. To remedy this trouble, I put shims behind the cams to move them ahead and thus cause fuel admission earlier in the cycle. I also checked the exhaust and intake valve cams, and made the necessary corrections to allow for wear.

One good method of checking injection timing is by watching the exhaust. The color of the exhaust from a cylinder firing late is a yellow blast each time the exhaust valve opens. The exhaust of a cylinder firing properly is blue and almost unnoticeable.

I would advise A.F.O. to take the exhaust valves out and not only to clean them, but grind them. Probably the late firing has pitted them. ART WILLIAMSON.

Kimball, S. Dak.

Air in Boiler Drum Causes Drop in Turbine Vacuum

I HAVE read with interest the comment of Ralph Emmons on page 153 of the September issue of *Power* regarding his method of putting boilers on the line to prevent drop in condenser vacuum.

The method followed in our plant is to leave the superheater drains open when the boiler is first fired and allow the noncondensable gases and condensate to be blown to atmosphere while pressure is being raised, closing them when the pressure has reached about 10 lb.

Our boilers are equipped with a non-return stop valve on the superheater outlet, followed by a gate valve with an open-end drain valve between the two.

When the pressure on the boiler has reached a few pounds the stem of the non-return valve is raised and the drain valve between it and the gate valve opened. This induces flow opening the non-return valve. The non-return valve and drain valve are then closed and the gate valve opened as soon as the line is well blown out.

When the boiler has nearly reached the line pressure the non-return valve stem is raised, and as the pressure in the boiler rises above that in the main the boiler gently cuts itself onto the line.

With this method no trouble is ever experienced with loss of condenser vacuum when a boiler is cut in.

No. Plymouth, Mass. C. B. HUDSON.

Another Slant on Embrittlement

C. G. ALEXANDER, in the November, 1932, number of *Power,* page 256, has indicted the purely chemical method of feedwater treatment as applied to systems operating under the increased steam pressures in vogue today. He points out that high boiler concentrations, reached in an endeavor to maintain the sulphate-alkalinity ratio, have resulted in carry-over followed by turbine nozzle and blade difficulties.

I am in accord with the views of Mr. Alexander in this and in that we should look to the physical sciences for a simpler and cheaper means of preventing caustic embrittlement.

It was pointed out by F. G. Straub (U. Illinois Eng. Exp. Station Bulletin No. 216) that the seat of the embrittling action lies at the grain boundary, and is due to the electromotive forces at these surfaces, together with mechanical stress. The latter may be controlled to some extent by proper designing. A study of the polar condition lies within the province of the physical sciences.

The regulation of the ionic concentration within a boiler has been carried to its logical conclusion. A great deal has been done to control caustic embrittlement by this means. It is evident, however, that if the strictly chemical methods of control lead to further evils, prompt modification or change is indicated.

The physical-chemical approach lies in controlling the electronic (in this case the anodic) state of the metal. It would appear that a high dispersion of negatively charged bodies throughout the boiler system would solve this problem. If a small amount of such a material were introduced along with a boiler feed, the action would be localized and specific at those points where e.m.f. differences obtained. Such a body is to be looked for among negative sols—such as the tang extracts—which are known to be stable at boiler temperatures and pressures.

It would be highly desirable for investigators of caustic embrittlement to study the problem more generally from a physical point of view.

Larchmont, N. Y. H. T. HOTCHKISS, JR.

Superheated Steam in Laundry

IN THE October, 1932, number of *Power* (page 207) N. W. Petefish discussed Mr. Friend's article, "Superheated Steam in Laundry." The next to the last paragraph of Mr. Petefish's letter reads as follows:

"Mr. Friend's idea of superheated steam on flat work ironers is fundamentally wrong. Satisfactory ironing conditions are secured from the latent heat in the steam, and no superheated steam can give up its latent heat until it has lost its superheat. Moreover, the unit heat transfer with superheated steam in the shell is much less than with saturated or moist steam in the same shell."

Theoretically, the unit heat transfer with the use of saturated steam is more than with superheated steam, as referred to above, but since it is impossible to have saturated steam without moisture, due to radiation losses in pipe lines, etc. that exists in a commercial installation, and also since the moisture in steam insulates on a condensing surface, a slightly superheated steam would be more effective in that the entrained moisture in the saturated steam would be eliminated and the insulation, due to the moisture film on the condensing surface, reduced.

In addition to the above, it is impossible to have a per-

fect distribution of saturated steam over the condensing surface, as well as it is impossible to take the condensate uniformly from the condensating surface. It is also due to this that slightly superheated steam is beneficial as it helps to compensate for this unequal distribution. Slightly superheated steam would not show an economic advantage if it were possible to design a condensing surface where the condensation and the draining would be uniform, and also if it were possible to deliver saturated steam without any moisture to the surface.

The above is borne out in recent practice and accounts for a greater saving obtained with a slight degree of superheat in the rolls of paper machines, as well as in smaller rolls in laundry work. This is an instance where practice must be combined with theory in order to obtain the most economical results.

New York City

W. H. ARMACOST
The Superheater Co.

Testing Non-Condensing Turbines For Efficiency

THE discussion of my article on "Testing Non-Condensing Turbines For Efficiency" by C. Harold Berry on page 259 of the November number of *Power* is of more than passing interest because of his close acquaintance with the present turbine test code. However, I am rather inclined to disagree with practically all of Mr. Berry's statements save one. This one is the general feasibility of determining the state of turbine exhaust steam when it is superheated. Granting this, there is hardly any serious objection to codifying such a method of test, and as my article briefly pointed out, there are great advantages—many more, in fact, than I specifically named.

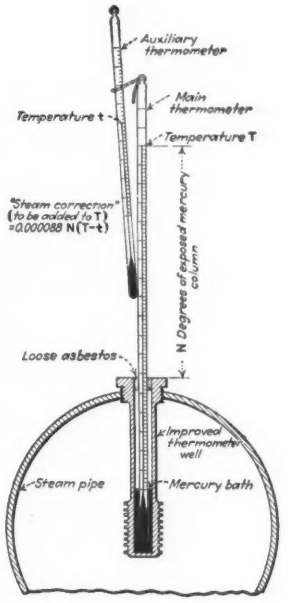
The photostatic copy of the Stansbury-Weil article (*Power,* Dec. 6, 1921) which I have just examined indicates, contrary to Mr. Berry's statement, that:

1. The method of test was not original with them. As a matter of fact the method is a "natural" one which anyone with a working acquaintance with a Mollier diagram will promptly discover. It is, one might say, almost obvious—a fact which I tacitly pointed out in my original article. I venture the assertion that it has been independently invented at least one thousand times in the past century.

2. Fig. 3 of the Stansbury-Weil article (reproduced herewith) is prima-facie evidence of itself why the method as described by them has not achieved any measure of usage. I maintain it is almost if not quite impossible under commercial or field conditions to get temperature measurements by this method which will compare in accuracy with that of a *precision* potentiometer, ice and water cold junction No. 20 gage calibrated thermocouple, and a fin-type well of proper depth and small bore which has its head well insulated. Another point not mentioned in the Stansbury-Weil article is the proper location of the wells to guard against conditions where the pipe is hotter than the steam. This is a rather anomalous but none the less real condition of considerable importance in testing many turbines—particularly those of some size where considerable temperature drops occur. Precautions like this, together with numerous others which largely determine success or failure, should logically be codified and so make generally available. Otherwise each tester has to go through laborious, time-consuming and expensive experiment perhaps even without finding out the reason for his troubles.

Mr. Berry's contentions that this is not a method of testing in the true sense of the word, that the methods presented in the code must be only those that are recognized as yielding the most dependable results attainable in the present state of the art, that the code can not lead practice but must follow, are all in my opinion rather fallacious and misleading. In the well-known Lamb story the Chinaman burned his house to roast a pig. That is rather crude but not more so than wasting heat in a surface condenser to measure its amount.

My electrical education left in me a very high respect for indirect methods of test. The method under discussion is hardly, more or less, than that. It is true that some consideration must be given to the turbine radiation loss, the packing steam disposal, perhaps even in extreme cases to the leaving loss. But these will not serve to invalidate the method, although admittedly they constitute elements that may have to be taken into consideration. But here again the desirability of the code comes in. It should start, of course, as a tentative or proposed code.



Method of getting steam temperatures. (Reproduced from article regarding Stansbury and Weil investigation, Power, Dec. 6, 1921.)

It seems natural for me to expect a code committee to work for the solution of present growing problems rather than to specialize, like archaeologists, entirely in the past. The boiler code has not been confined to posthumous-like standardization; otherwise welded drums would hardly be included in its provisions today. If every turbine has a surface condenser, that is one story, but if a large and growing number have none, that is something else.

In my own experience I have accumulated a fair amount of data and information on this method. There may be and probably are a considerable number of other engineers who have similar and more extensive information. So long as this lies isolated it does the engineering profession little good. The object of my article in the August number of *Power* (page 74) was to indicate, without submitting a lot of tabulations, a few of the considerations that might serve to make this method of testing more reliable and perhaps draw from others additional information. As an A.S.M.E. member with a moderate amount of experience in designing, testing and operating, I feel that the method might perhaps deserve more extensive investigation than it has apparently received. A method of turbine test which involves a condenser becomes only a mythical test if there is no condenser. A test code, among other considerations, can hardly afford to ignore that. Nor can it logically fail to consider that superheat in the turbine exhaust is becoming quite common in modern industrial plants and will, I predict, become more so.

Hamilton, Ohio.

GUY B. RANDALL,
The Champion Coated Paper Co.

READERS' PROBLEMS

WHAT IS ONE MOL OF CARBON?—*In the article entitled "The Mol," by E. F. Dawson, which was published in "Power" for December, 1932, a mol of any substance is defined as "the quantity whose weight in pounds is expressed by the same number as its molecular weight." This is illustrated as follows:*

1 mol O_2 is equal to 32 lb.
1 mol N_2 is equal to 28 lb.
1 mol C is equal to 12 lb.

Why is it that in the case of carbon, the atomic weight is used, and in other cases the molecular weight? B. C. G.

Where the element considered is a gas at ordinary temperature the molecular weight is used in figuring the "mol." This makes mols directly proportional to gas volumes. In the case of an element like carbon, which is not a gas, the mol relation cannot, of course, be used to figure volumes, hence nothing would be gained by using C_2 instead of C. Moreover the atoms per molecule of an element cannot be determined except when it is in gaseous form.

However, any one who wishes may arbitrarily write the carbon molecule as C_2 and compute chemical problems correctly on this basis. For example, we now say, assuming 1 mol of carbon equals 12 lb.:

$$\begin{aligned} C + O_2 &= CO_2 \\ 1 \text{ mol} + 1 \text{ mol} &= 1 \text{ mol} \\ 12 \text{ lb.} + 32 \text{ lb.} &= 44 \text{ lb.} \end{aligned}$$

If we take the molecule of carbon to be C_2, the mol will be 24 lb. and we have

$$\begin{aligned} C_2 + 2O_2 &= 2\ CO_2 \\ 1 \text{ mol} + 2 \text{ mol} &= 2 \text{ mol} \\ 24 \text{ lb.} + 64 \text{ lb.} &= 88 \text{ lb.} \\ \text{or } 12 \text{ lb.} + 32 \text{ lb.} &= 44 \text{ lb.} \end{aligned}$$

which is, then, but another way of saying the same thing. Either method would be "correct," but that given in the article is more convenient in problems involving gases.

RATE OF CHARGING A STORAGE BATTERY—*Knowing the size and number of plates in a lead storage battery, how can the normal charging current rate be determined?* C. N.

The best way would be to write to the manufacturer and obtain full instructions for the care and operation of the battery. In the absence of doing this, the normal charging rate in amperes may be determined by multiplying the area, in square inches, of both sides of the positive plates by 0.04. For example, assume a battery having 25 plates each 16x18 in. In this battery there would be 12 positive plates, each with a total area of 16x18x2 = 576 sq.in. As there are twelve positive plates the normal charging rate will be 576x12x 0.04 = 276.48 amp.

Where the ampere-hour capacity of the battery is known, the normal charging rate can be determined by dividing the capacity by 8. Assuming a battery of 2,000-amp.hr. capacity, its normal charging rate would be 2,000 ÷ 8 = 250 amp.

Other factors should be taken into consideration when charging the battery, such as the temperature of the electrolyte and the voltage across each cell. The temperature of the battery should not be allowed to exceed 110 deg. F. In case the temperature exceeds this value the rate of charge should be reduced.

The voltage across each cell should not exceed about 2.5 volts when the battery is charging. Except for short periods the rate of charge should not be so high as to cause violent gassing of the electrolyte. With the battery discharged, the normal rate of charge should be such as to bring it back to full charge in about 10 hours.

CALCULATING SUCTION HEAD ON A PUMP. *How is the suction head on a pump figured, and what is the maximum suction head allowable for good operation?* M.R.

Apparently the questioner has in mind suction lift and not suction head. Suction head is the condition that exists when the center line of the pump is below the level of the source of supply. The distance from the pump's center line to the surface of the source of supply is the static suction head. With the pump in operation there will be a loss of head in the suction pipe due to entrance losses and friction. The static suction head, minus the velocity head, minus entrance and friction losses but not the internal pump losses, is the dynamic suction head. It is evident that the dynamic suction head is always less than the vertical distance between the pump's center line and the surface of the source of supply.

Suction lift exists when the surface of the source of supply is below the center line of the pump. The static suction lift may be defined as the vertical distance from the center line of the pump to the free surface of the supply. When the pump is in operation, as previously mentioned, there are losses at the suction-pipe entrance and due to the friction of the water in the pipe. The static lift plus these losses plus the velocity head is the total suction lift on the pump, or as it is frequently called, the dynamic suction lift. From this it is seen that the dynamic suction lift is always greater than the vertical distance from the pump's center line to the surface of the source of supply.

Under conditions where a pump has a very low static suction head it may have a suction lift when in operation. For example, if the static suction head is two feet and the entrance losses plus friction plus velocity head amount to five feet, then the pump is operating under a 5 — 2 = 3-ft. suction lift and not a suction head.

On a reciprocating or a rotary pump the dynamic suction lift should not exceed 22-ft., and on a centrifugal pump it should not in general exceed about 15 ft. A vacuum gage connected into the suction line at the pump's intake will indicate the total or dynamic suction lift when the pump is in operation.

Causes of and Remedies for Flat Spots on Slip Rings

Answer to the Question in November Number

WE have a 1,000-kva., 2,300-volt, 60-cycle, 3,600-r.p.m. alternator, driven by a steam turbine, that has been giving trouble by developing flat spots on one of the exciting-current slip rings. The ring has been trued and polished and the leads interchanged, but it continues to develop burned spots all around its surface. It does not seem that the trouble is in the brushes, as they are those recommended by the machine manufacturer; their spring tension has been checked, and they move freely in the holders. M.R.C.

Recommends Increasing Brush Cross-Section

A POSSIBLE cause of the flat spots is the brushes having insufficient cross-sectional area. In some cases where trouble was experienced with flat spots on slip rings, adding one or more brushes has remedied the fault. Changing the grade of brush used might improve conditions. When correcting trouble of this kind first make sure that the rotating part is not unbalanced and that the rings run perfectly true. When these conditions are known to be cor-

rect and the trouble persists, try increasing the area of the brushes in contact with the rings. Apparently the metal of the ring itself influences the most suitable kind of brush.

All rings tarnish to some extent, especially those of an iron alloy. The tarnish increases the contact resistance and occurs when the machine is at rest. As part of the ring is covered by the brushes this discoloration will not be uniform, consequently the contact resistance round the ring will not be equal and may cause flat spots. Trouble due to discoloring can be prevented by frequent cleaning. If before the machine comes to rest the ring is dressed with paraffin wax, the film formed will prevent tarnishing. W. E. WARNER.

Welwyn Garden City, England.

Trouble Corrected by Changing the Brush-Holders

I HAD the same trouble on smaller machines operating at the same speed as M.R.C. It was found that if the rings were ground true while the machine was running at full speed, the brushes would operate for several months before any sign of sparking would develop.

While the question does not so state, presumably the rings are steel, and the trouble may be caused by hard and soft spots in them. On one machine that I had experience with a new radial-type brush-holder was applied with coiled springs acting directly on the ends of the brushes. With this arrangement, the brushes have given no further trouble. A. R. MARKLAND.

Altoona, Pa.

Changed From Soft to Harder Brushes

I HAD a similar experience to M.R.C., and my method of correcting the fault may be helpful. In my case the trouble was with a synchronous motor. Burned spots developed on the rings until sparking became so severe that the rotor had to be removed and rings trued. The spots occurred on the ring where the direction of current flow was from the ring to the brush. The trouble rapidly increased until a series of spots about a brush span apart were formed around the ring.

The brushes were of a soft graphite, the same as recommended by the manufacturer. It was found that these brushes had a tendency to pick up sufficient dust from the rings to affect the brush contact. It was undoubtedly caused by the application of field current at full strength, the rush of current being sufficient to cause a slight arcing under the brush which roughened the ring and a flat burned area developed.

The brushes were replaced with slightly harder ones which also had a higher conductivity. The rings were trued and then polished with a block having its inner surface an arc closely fitting the ring, covered with No. 0 sandpaper. Since putting the machine into service again an occasional sanding with this block is done while machine is running. The brush leads are interchanged at intervals before there is any indication of even slight sparking at the brushes and starting is done at a reduced field strength. Since the correctives have been adopted no trouble has been experienced with the rings. T. E. STUART.

Council Bluffs, Ia.

A Question for Our Readers

IN OUR plant most of the power is generated as a byproduct of process steam. At times, however, there is a considerable waste of exhaust steam, some of which might be prevented by certain possible shifts in the power and process loads. We wish to install a device that will indicate at all times whether the atmospheric relief valve is open and if possible show how much steam is being wasted. I would like very much to get the suggestions of Power *readers.* S.W.P.

Suitable answers from readers will be paid for if space is available for their publication.

Slip Rings Are Defective

FROM the question it seems that everything has been checked for trouble on the alternator, and I would suggest that if this is a new unit the manufacturer be asked to supply a new ring for the machine. It is the poor quality of material in this particular ring that is causing it to burn and wear flat spots. I had a similar case with a 22-hp., 440-volt, slip-ring motor always burning one particular ring. After I tried to correct the trouble and renewed the brushes three times, a new ring was installed which eliminated the fault.

Pittsburgh, Pa. JAS. I. BALSLEY.

Electrolytic Action Causes the Trouble

I HAVE had trouble with slip rings to the extent that it developed into short circuits between the rings. This trouble does not originate from burning, but is caused primarily from an electrolytic action between the ring and the brushes. This electrolytic action will deposit a film of carbon from the brush to the ring in such a manner that when the generator is run full speed and load, more carbon will deposit on the ring, which will in turn cause the brushes to jump and begin to arc. The brushes are not the cause of the trouble, although in some cases, the trouble can be cured by using more abrasive brushes. The solution to the trouble is to keep the rings clean by frequent sandstoning, or turning and polishing.

A. T. APPLETON,
Supt., Winnipeg Hydro Steam Plant.
Winnipeg, Man.

Excessive Lead in the Rings May Cause Black Spots

IF ON polishing the rings, the spots reappear in different places, the cause may be due to some part of the turbine or generator being slightly out of balance. It is my opinion, however, that the trouble is because of faulty metal in the rings. The rings are cast from copper and turned to exact shape. Pure copper does not cast nor machine well, so it is customary to add a small percentage of zinc or tin and one or two per cent of lead.

Tin or zinc will alloy with copper in any proportion, but lead will not. If any excess of lead is added, it will tend to segregate in spots, sometimes large enough to be seen. One railroad in the West had a formula for car axle brasses that called for not less than 5 per cent of tin and not more than 5 per cent of lead, 80 per cent copper, balance zinc. When made from virgin metal this was all right, but when using recovered ingots, which already had about all the lead they could carry, spots of lead as big as a dime would appear on the finished surface.

In M.R.C.'s case, lead segregations would appear black because of the relatively poor conductivity of lead, causing overheating at that point.

St. Louis, Mo. L. R. BAKER.

Installed Reversing Switch In the Field Circuit

IN EVERY alternating-current machine with slip rings connecting to a direct-current exciting source there is an electrolytic action between the slip rings and brushes that seems to be worse on steel rings than copper or brass ones. On a 300-hp., 600-r.p.m. synchronous motor this trouble showed up before three months' operation. It was eliminated by placing a two-pole, double-throw reversing switch in the field circuit and throwing this switch to its opposite position every morning before starting motor. Thus the polarity of the slip rings was changed every day. On less severe cases field wires are reversed periodically to insure even wear of rings.

Hudson, Mass. GEO D. NOILES.

TRANSATLANTIC TRENDS

(Continued from page 36)

Last winter two Loeffler boilers, each for 60-75 tons of steam per hour, and operating at 1,900 lb. and 932 deg. F., went into operation at the Caroline Mines power station, Moravska Ostrava. It is reported that these units are operating efficiently, with no trouble whatever. Based on their operation the United Moravian Silesian Electricity Works decided to equip their new station in Trebovice with Leoffler boilers. The erection at that station of three boilers, each producing 60-75 tons of steam per hour, is now nearing completion.

Russian engineers have ordered two Loeffler units, each to deliver 130-160 tons of steam per hour, for the high-pressure station of the Heat Institute of Moscow. Erection is now well advanced.

Development of the Velox pressure-combustion boiler continued. An experimental plant, capable of producing 22,000 lb. of steam per hour, has been running at the Baden (Switzerland) works of the Brown Boveri Co. since the beginning of the year. The first commercial installation, intended for a French steel plant, will be tested at Baden before this number goes to press. Three other plants, for 27,000, 40,000 and 56,000 lb. of steam per hour, respectively, are in course of construction. All of these installations use constant-pressure combustion. The explosion principle has been applied to only one small experimental plant.

Fig. 3 shows the general arrangement of the constant-pressure combustion boiler for fuel oil. Combustion takes place at several atmospheric pressures. The combustion gases stream at high velocity through tubes surrounding the furnace. The gases, partly cooled, pass through a superheater to a gas turbine, and then to the economizer, before going to waste. The gas turbine is connected to a turbo compressor and to a boiler circulating pump, designed to maintain a rapid circulation and increase heat transfer on the water side.

The Velox plant for a French steel plant is to be fired by blast furnace gas. It will deliver 30,000 lb. of steam per hour at 450 lb. and 800 deg. F.

The following brief report of the power situation in Japan is based on a letter from Mitsubishi Shoji Kaisha, Ltd.: In the past the main dependance has been upon hydraulic power. But recent developements in the use of high-pressure and high-temperature, etc., have placed the steam plant in a much more advantageous position. In spite of industrial depression, there has been an increase of new construction of large and small central power stations, or extensions of existing plants, and also in industrial power-process steam plants. A 150,000-kw. plant is under construction for the Kansai Kyodo Karyoku Hatsuden K. K. Amagasaki Station. This plant will have an ultimate capacity of 300,000 kw., and will then be the largest steam station in Japan.

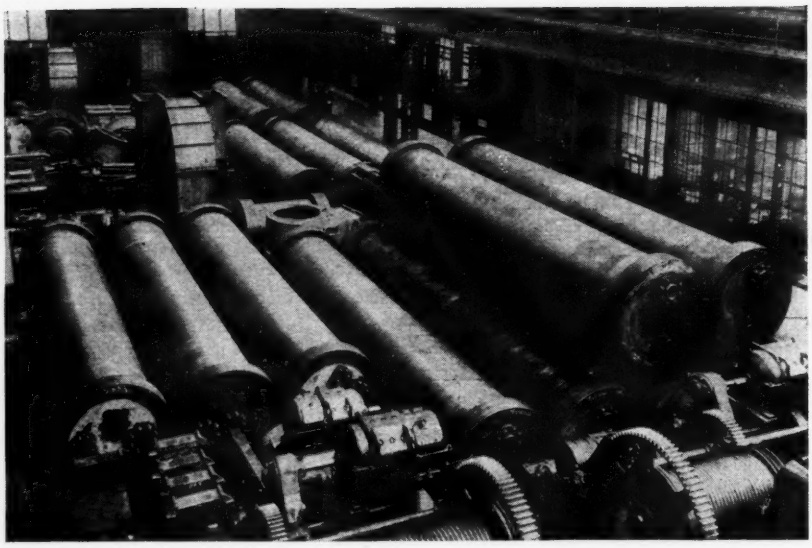


Fig. 4—Loeffler evaporator drums at factory ready for shipment to plants at Trebovice and Moscow

The remarkable power projects of Magnitorgorsk, Russia, were described in the August number of *Power*. Briefly, plants under construction in this new steel city are designed for an ultimate aggregate capacity of 542,000 kw. In addition, steam-turbine driven blowers for blast furnaces will have a combined capacity of 1,115,000 cu.ft. per min.

Hydro development in Europe has been unusually active and several records have been established. Low-head projects are most numerous, and for these Kaplan turbines are being used almost exclusively. For a résumé of these developments attention is called to the table on page 20. In this are listed 33 outstanding European hydro projects with a total capacity of 1,245,000 hp., most of which have installed Kaplan turbines.

Among these the Ryburg-Schwörstadt plant is of particular interest because of its size and having been tested. These turbines, which have a normal rating of 38,700 hp., gave a maximum efficiency of 92 per cent, and for a range of load of 12,150 hp. to 35,000 hp. their efficiency was above 90 per cent. The four units in the Swir development, Russia, and the three units in the Dogern project on the Rhine, between Germany and Switzerland, are comparable in size and head to those in the Ryburg development.

Another outstanding feature in Kaplan-turbine development is the high heads for which they are being built. The 33,000-hp. unit for the River Shannon plant in Ireland is being designed for a maximum head of 106 ft.

For francis-type turbines a record was established for head in the Zappello plant in Italy, where two 5,000-hp. horizontal-shaft units are being operated under a head of 1,150 ft.

Among outstanding pelton-wheel installations are the two units in the Niederenbach plant, Switzerland. These are rated at 11,450 hp. and operate under an effective head of 3,285 ft., with a static head of 3,560 ft. These are the highest head waterwheels of their size in the world. The four horizontal-shaft units in the Vermunt plant, Austria, are rated at 33,250 under a 2,350-ft. effective head and each has a single runner and nozzle.

Pumped-storage plants continue to find an ever increasing sphere in Europe's plans for power developments. Several very large plants of this type have already gone into operation and a number are under construction. As an example of these the Schluchsee plant, which went into operation recently, may be mentioned. This plant has four 48,000-hp. turbines and the pumps required 30,000 hp. to drive them. These units are of the vertical type with the generator-motor on top, the turbine below the generator and the pump under the turbine. The Lac Noir plant now under construction in Alsace, France, will have four 38,000-hp. units with pumps requiring 23,000-hp. to drive them. These machines are also of the vertical type.

An outstanding trend in European waterwheel construction is the use of stainless steel. Of the 33 projects listed in the table on page 20, twelve are reported as having runners of stainless steel. For example, each blade on the four Swir runners weighs 10.5 tons and is made of stainless steel. Four 17,000-hp. pelton-type wheels were shipped from England to India during the year, for the Shanan plant, to operate under 2,000-ft. head. These wheels have buckets of stainless steel cast in pairs. The needles and orifices are also made of stainless steel.

Oil-engine developments in foreign countries have been notable. Those of particular interest to American engineers are presented in the general article on oil and gas power in this number.

THE ENGINEER'S BOOKSHELF

Social Trends

RECENT SOCIAL TRENDS (1933). *Published by the McGraw-Hill Book Co., Inc., 330 West 42nd St., New York, N. Y. 1,700 pages, 6x9½ in. Clothboard covers. Two volumes, $10 per set.*

When one has work to do or studies to make, in which previous experience or existing conditions in the same field are involved, what does one do? He immediately gathers, from every available source, all of the existing background knowledge and facts dealing with the subject that it is possible to assemble. These data are then assembled, classified and weighted according to quality and quantity. In the process the names and standing of authors bears heavily upon the general usefulness of their statements.

These two volumes on Recent Social Trends are a rich source of the most up-to-date information for use of anyone in the power field who has need for statistical data and authoritative information over an extraordinarily wide range of investigation.

As the foreword, by President Hoover, points out the work contains a review of the President's Research Committee on Social Trends which was appointed in 1929 under the Chairmanship of Dr. Wesley C. Mitchell. This is followed by 29 chapters, each dealing with a specific division of the problem and handled by one or more authorities on their subjects.

While, from the title of these two volumes, a review of these books in POWER may seem out of place to some readers, the books contain a wealth of material which will undoubtedly be of great value to others. Students of trends in the industrial arts and of power generation and consumption will find in the books a hoard of valuable information.

Engineering and Design

POWER PLANT ENGINEERING AND DESIGN (1932). *By Frederick T. Morse, E. E., M. E., Member of the faculty of engineering, Louisiana Polytechnic Institute. 813 pages, 6x9 in. Clothboard covers. Indexed. 353 illustrations. Problems. Mollier diagram. Published by D. Van Nostrand Co., Inc., 250 Fourth Ave., New York, N. Y. Price $6.50.*

The theory of stationary electric generating plants is covered by this text for engineers and students of engineering. It endeavors to present, in one volume, a thorough study of public service, industrial and institutional plants. Mechanical, electrical and economic features are all considered simultaneously. Recent developments are treated in their proper relation to older established practices, although because of space limitations no single subject is treated as exhaustively as it would be in specialized texts.

A listing of chapter headings will probably give best indication of what the text contains: Variable Load Problem, Power Plant Economics, Power Plant Building, Diesel Engine Power, Hydro-Electric Plant (2 chap.), Vapor Cycles and Their Heat Balances, Steam Boilers, Prime Movers and Condensers, Combustion Loop, Feed Water Loop, Piping System, Electric System Equipment, Electric System Layout, Conclusion (Meters, etc.). One feature of the book, which recommends it particularly in this reviewer's eyes, is the fact that a bibliography of additional references is given at the end of each chapter, affording the student opportunities for further study of a particular subject if he so desires.

Fuel Data

TECHNICAL DATA ON FUEL. *Edited by H. M. Spires. Third Edition, revised and much enlarged. Published by the British National Committee, World Power Conference. 5x7½ in., 300 pages, 210 tables, 57 diagrams. Price $2.75. Obtainable through American National Committee of the World Power Conference, Chrysler Bldg. New York, N. Y.*

This little volume, originally published as one of the British contributions to the Fuel Conference of 1928, now appears in its third edition with about 75 per cent more material than the original publication. The added material includes rather complete data on pyrometers, the standard VDI orifices and nozzles, a very well written and comparatively full section on viscosity, reasonably complete tables of the properties of air, water, steam (including the International skeleton tables), ammonia, carbon dioxide, sulphur dioxide, mercury, diphenol and other fluids used in power production and refrigeration, a rewritten chapter on heat transfer and an entirely new section on flame temperatures, calorific values and dissociation. Considerable material has been added on coal washing, and the book is remarkable for the large number of nomographic tables for the quick solution of rather involved equations. The units used are the CGS, ft.-lb.-sec., and meter-kg.-sec., and extensive conversion tables are included. The volume is interleaved with many blank pages for the insertion of other data as it appears. A good deal of this matter has not been previously published and the volume will be welcomed by the many engineers who are engaged in the solution of fuel problems. *—Reviewed by George A. Orrok, consulting engineer.*

Power Costina

POWER ECONOMY IN THE FACTORY (1932). *By J. C. Todman. Published by Isaac Pitman & Sons, 2 West 45th St., New York, N. Y. 215 pages, 5x7 in. Clothboard covers. Indexed. 41 illustrations. $2.25.*

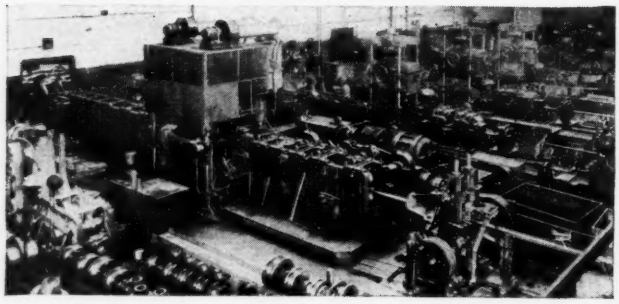
This is a book for cost and works accountants and also for students intending to enter for the Power Generation and Transmission section of the Institute of Cost and Works Accountants (British). As a consequence, it is a more or less elementary text but serves to provide him who reads it with the elements of power knowledge necessary to check up an industrial power plant and system to obtain greater economies if possible. Further, it provides an easily readable text on the elements of power generation.

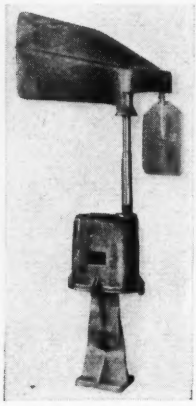
PROPERTIES OF MATERIALS AT HIGH TEMPERATURES. Special report No. 18 of the British Department of Scientific and Industrial Research. 44 pages, 6x9 in. Paper covers. Price 9d. net.—Gives strengths at high temperatures of six steels and three non-ferrous metals. The Department at 16 Old Queen St., Westminster S.W., England, supplies it.

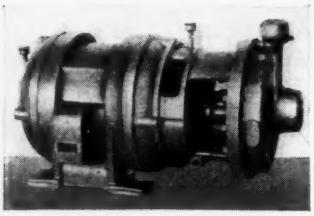
25TH BERICHTEFOLGE DES KOHLENSTANBAUSSCHUSSES DES REICHSKOHLENRATES (25th report of the Pulverized Fuel Committee of the Reich Fuel Council). 62 pages, 8¼x11¾. Paper covers. 62 illustrations and 31 tables. Available from the V. D. I. Verlag G. M. B. H., Berlin, N. W. 7, Dorotheenstrasse 40, Germany. Price 2 marks.—Contains six papers on the subject, presented during 1929, 1930, and 1931.

WORLD SOCIAL ECONOMIC PLANNING. Papers on this subject presented before the 1931 World Social Economic Congress, and the subsequent discussion. Available from International Industrial Relations Institute, 130 East 22nd St., New York City. Price $2.50.—Present-day thought on this topic, plus an analysis of it and material in an earlier book from the same source on "International Unemployment."

WHAT'S NEW IN PLANT EQUIPMENT







Combined Motor and Pumping Unit

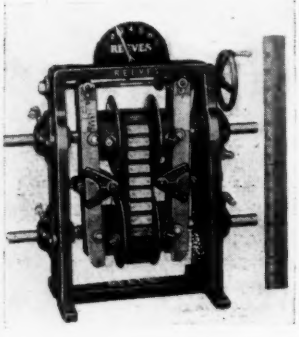
The line of "SSU" motor-driven single-shaft two-bearing pumping units has been extended by three sizes to work against heads up to 100 lb. (231 ft.) and above and covering a range in capacity from 30 to 140 g.p.m. Suitable for any high-head, low-capacity service. Motor rotor and pump impeller on same shaft, ball bearing supported.

Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Small Vertical Variable Speed Transmission

No. 0000 Reeves vertical-type variable-speed transmission is claimed smallest ever built, being but 15 in. high. Provides accurate speed regulation in limited space. May be equipped with motor base and individual driving motor, with auxiliary countershaft for greater speed reduction, and with extended lever-type Reeves mechanical automatic control. Also available in completely inclosed design. Speed range from 2:1 to 6:1, capacity, $\frac{1}{8}$ to $\frac{3}{4}$.

Reeves Pulley Co., Columbus, Ind.



Continuously Welded Boiler Tubing

Ranging from $\frac{3}{16}$ to 5 in. outside diameter, this line of welded tubing for high-pressure boiler work is formed by feeding flat strip through forming rolls as shown above. Tubing, formed cold, is passed through four pressure rolls, upper pressure roll being also electric welding unit composed of two circular electrodes and necessary transformer and brush contacts. Only edges in contact are raised to welding temperature. Tubing shaped and extruded metal inside taken off while weld is still plastic. Sizing rolls bring tubing to exact O. D. desired, and insure straightness. Surface inspection constantly, and splitting test every 15 min. Also tested by A.S.T.M. methods for lap-welded and seamless steel and lap-welded iron boiler tubes, including flattening, hydrostatic and chemical tests.

Steel & Tubes, Inc., subsidiary of Republic Steel Corp., Cleveland, Ohio.

Water-Softening Equipment

"Inversand" zeolite water softeners clarify and soften waters containing an appreciable amount of temporary or carbonate hardness. Equipment easily accessible, compact and automatic, and softened water claimed to be crystal clear, 100 per cent soft and in strict conformity with accepted specifications of A.S.M.E. in regard to sulphate-carbonate ratio.

Hungerford & Terry, Inc., Clayton, N. J.

Chemically Resistant Rubber Belting

Rubber belting which resists the destructive action of acids, alkalies and oils three times as long as ordinary belting has been invented by B. S. Taylor, manager of material development for Goodrich processing division.

B. F. Goodrich Co., Akron, Ohio.

Corrosion-Resisting Roller Chain

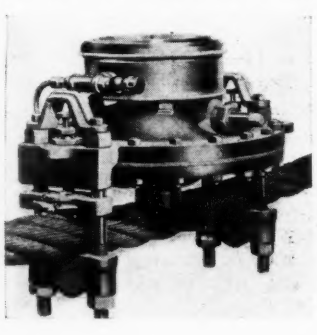
"Silverlink" roller chain has specially treated sidebars to assist in resisting corrosion. All sizes from $\frac{3}{8}$ to $2\frac{1}{2}$-in. pitch, and in single or multiple widths. Available with wheels for any horsepower, also with conveying attachment links in wide variety, and complete drives are carried in stock by distributors in sizes up to 225 hp., in speed ratios of 1 to 1 up to 8 to 1.

Link-Belt Co., Indianapolis, Ind.

Tension Indicator

A new feeler gage has been designed to increase efficiency of Martin-Decker tension indicators. Gage is incorporated in indicator itself at a point underneath clamping device, and makes it possible to determine exactly when instrument is in correct position on cable for accurate reading. Feeler gage is a knurl-edged disk fitted beneath V-blocks which receive cable. As clamps are tightened, disk may be turned freely with thumb or forefinger until correct pressure is applied. At this point, action of disk is automatically retarded by friction against block. On heavy-duty type indicator, a micrometer deflection and saddle adjusters replace series of deflection plugs for various size lines.

Martin-Decker Corp., 3431-45 Cherry Ave., Long Beach, Calif.



Modulating Thermostatic Temperature Control

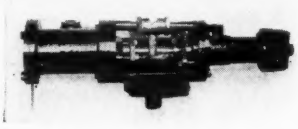
"Superstat" instrument integrates effect of wind velocity, sun, and outdoor temperature into a common effect converted into a valve position by power unit incorporated. Twelve valve positions are provided in a temperature range of 65 deg. F. plus wind velocity value. Acting upon a pressure-reducing valve it provides proper pressure for interior heating. All automatic. Provided with wider temperature range for more rigorous climates. Relative values in standard instrument are 10 parts of motion for temperature, 4 parts for wind and 2 negative parts for sun effect. Standard instrument puts on maximum steam at zero F. with 40-mi. wind.

Superstat Co., 38 Walter St., Springfield, Mass.

Square-Case Synchroscope

A new synchroscope of the moving iron-vane type has been added to Type H line of square switchboard instrumentss. New instrument characterized by low energy consumption, burden of each circuit being about four volt-amperes, making instrument suitable for use with condenser bushing potential devices. Position indicators and 360-deg. scale power factor meters are also available in this form.

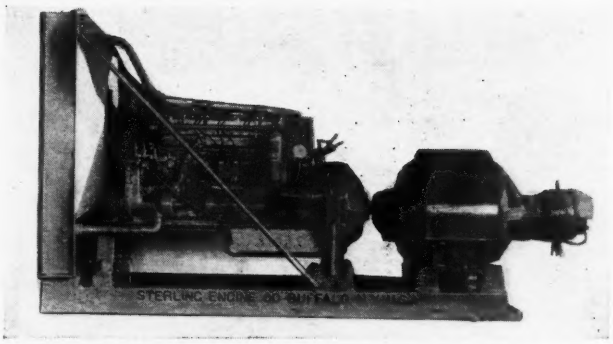
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.



Flow-Responsive Rotor

"Tret-O-Unit" automatic proportioning pump, described in *Power* in July, 1932, has been redesigned as a horizontally mounted machine suitable for mounting above any standard water meter for controlling purposes or as a flow-responsive rotor. Turbine-type rotor having bearings external of pipe line can handle corrosive, abrasive, or high-temperature fluids without maintenance difficulties.

Proportioneers, 77th & Avalon Ave., Chicago, Ill.



Engine Generator Unit

This Sterling Petrel engine, bore 5¼ in., stroke 6 in., is rated at 115 hp., 1200 r.p.m., direct-connected through flexible coupling to a 45-kw., G.E. generator. Engine is cooled by fan and Young radiator and mounted on cast-iron bedplate with generator. Twin carburetors with integral drip pans and flame arresters, dual ignition, gasoline pump, oil filter and control panel with engine instruments mounted thereon are included in latest features incorporated. Designed for constant operation.

Sterling Engine Co., 1252-1274 *Niagara St., Buffalo, N. Y.*

Rotary Positive Displacement Pump

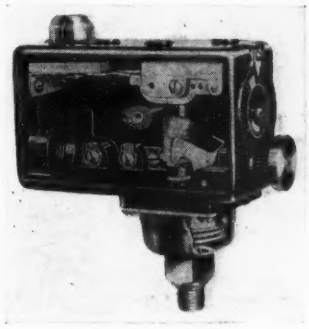
DeLaval-IMO rotary displacement pumps have ability to run at speeds heretofore considered impracticable for displacement pumps. Power is applied to a central or power rotor, which meshes with one or more sealing rotors of such form that they are propelled largely by fluid pressure, with a minimum of mechanical contact. This results from ingenious thread shapes, those of power rotor being convex while those of idler rotor are concave. This patented tooth form accomplishes sealing effectively so that numerous turns of thread around rotor, as found in common screw pumps, are not required in order to keep slippage low. Efficiencies of 80 to 90 per cent have been obtained. Liquid velocity through pump is low, and there is no trapping or cutting off of liquid in tooth pockets. Only three moving parts, and except for small thrust buttons to maintain relative axial positions of rotors, no separate bearings are used, nor are pilot gears required. Only one stuffing box used. Capacities from ½ to 700 g.p.m., and pressures up to 500 lb. per sq.in. Pumps for higher pressures and capacities can be supplied. Bulletin listing these pumps for oil service available.

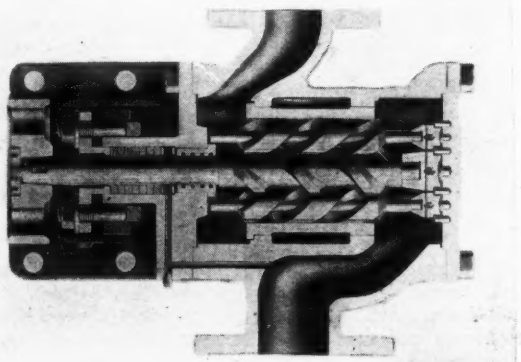
DeLaval Steam Turbine Co., Trenton, N. J.

Control Switch

Nos. 250 and 251 "Genuine Detroit" control switch for pressure, vacuum, and temperature carry full line current of 110 or 220 volts. A bellows element, actuated by pressure direct or by a volatile liquid for temperature, operates switch mechanism to make and break circuit. A permanent magnet at contacts provides quick make and break and prevents excessive arcing. Will carry 110 or 220 volts a.c. or d.c. Through use of an automatic starting switch units of any size may be controlled. All models inclosed in black Bakelite case with removable cover. Both operating range and differential are adjustable. Adjusting wheel at right end of case controls range adjustment, and differential adjustment is at top; ½-in. connection provided for BX or conduit. Furnished single pole, single throw, either "make at low," "make at high" or double throw.

Detroit Lubricator Co., Trumbull, Lincoln, Marquette & Viaduct, Detroit, Mich.





Turbine Oil

This turbine oil is guaranteed to last as long as turbine itself. "Nonpareil" does not react with air and does not change under use in a turbine, thus avoiding delays due to shut-downs for oil changes and for maintenance.

Standard Oil Co. of Indiana, 910 *S. Michigan Ave., Chicago, Ill.*

Steam Jet Refrigeration Unit

Suitable for cooling water for air-conditioning, drinking water, or any industrial process requiring water at a temperature between 35 and 60 deg. F., this steam jet refrigeration unit operates on low-pressure steam at 12 lb. gage and has refrigeration capacity of 2.5 tons at 50

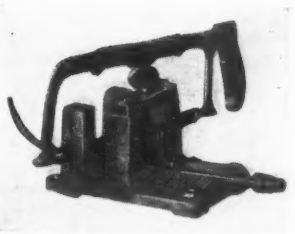
deg. Units of this type are made to operate on any steam pressure available from atmospheric up, in sizes from 2 to 20 tons. Units larger than 20 tons are made of horizontal type with same principle of operation.

Ross Heater & Mfg. Co., Inc., 1407-1411 *West Ave., Buffalo, N. Y.*

Square-End Sawing Vise

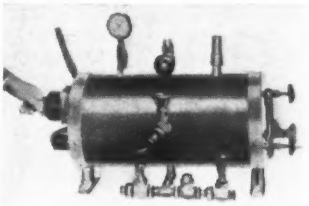
Beaver square-end sawing vise for thin-wall copper or brass tubing, ⅛ to 2 in. in diameter, will not crush nor mar the pipe. It is self-contained, quick-acting, light in weight, and simple to use. A reversible vise block permits all sizes of tubing to be locked into position quickly. Thumb screw prevents overpressure and crushing. Long V-trough insures accurate centering, and saw guide prevents saw-blade from running. Device is made of aluminum and is accompanied by strip of cotton webbing and piece of rosin for use when cutting polished tubing.

Borden Co., Warren, Ohio.



Miniature Electric Steam Generator

Miniature electric - heated steam generators, in a range of 2, 3, 4 and 5-kw. capacity, have been added to line. Sizes of 2,



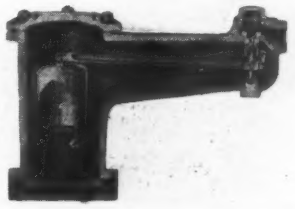
3, 4 and 5 kw. correspond to 6, 9, 12 and 15 lb. of steam by weight generated per hour. Operate on any electrical circuit, d.c. or a.c., in all steam pressures, ½ to 100 lb. gage. General Electric "Helicoil" full-immersion heating unit, three-heat control snap-switch on standard outlet box, 85 per cent magnesia heat - insulation, and welded seamless steel shell. A.S.M.E. safety valve, pressure gage, and similar equipment.

Commonwealth Electric & Mfg. Co., 83-105 *Boston St., Boston, Mass.*

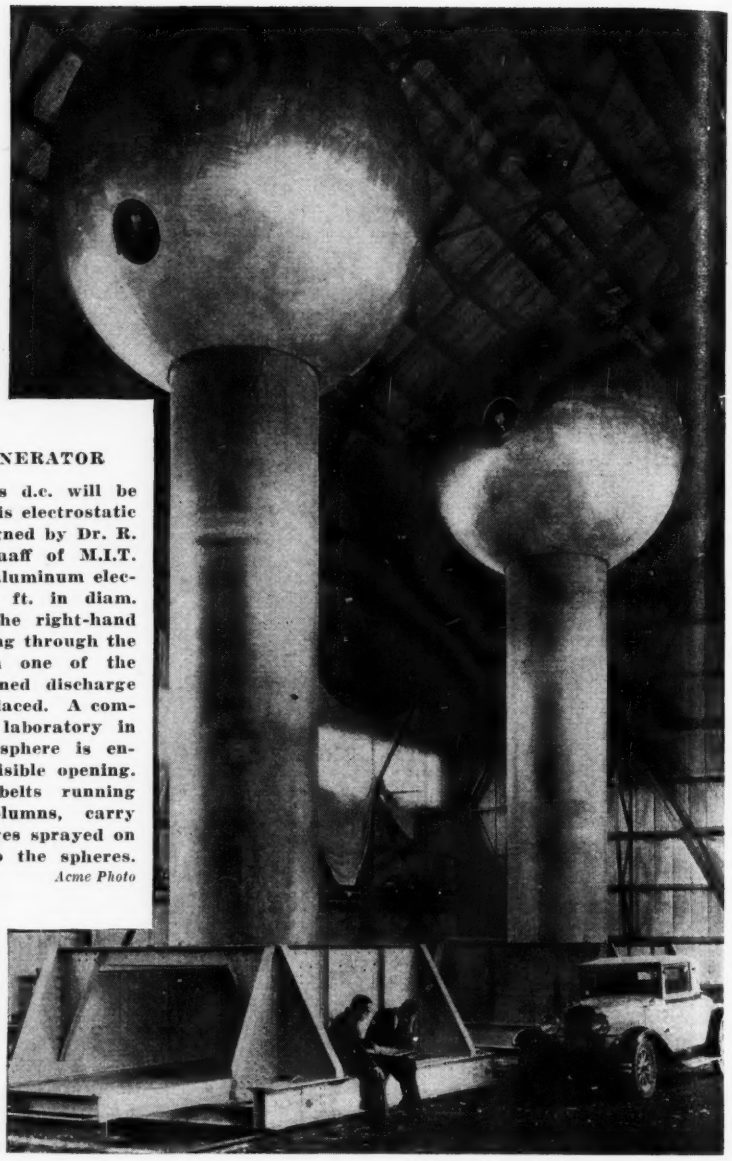
Inverted-Bucket Steam Trap

"Bundy Junior" non air-binding steam trap is fully adaptable as a flood trap to discharge large volumes of condensate into a vacuum return line. Thermally operated, thus requiring no thermostatic traps in connections. All parts renewable without disturbing connections. Sizes from ¾ to 2 in., in capacities from 3,385 lb. of water per hour, at 5 lb. pressure, to 34,680 lb. per hour at 200 lb. pressure.

Bundy Steam Trap Co., Nashua, N. H.



POWER LINES



GIANT GENERATOR

10,000,000 volts d.c. will be produced by this electrostatic generator designed by Dr. R. J. Van de Graaff of M.I.T. The spherical aluminum electrodes are 15 ft. in diam. The man in the right-hand sphere is looking through the hole in which one of the specially designed discharge tubes will be placed. A compact research laboratory in the left-hand sphere is entered by the visible opening. Endless silk belts running inside the columns, carry electrical charges sprayed on at the base to the spheres.

Acme Photo

Engineers' Day and Week for Chicago World's Fair

PROBABLY one of the largest conferences of engineers ever held will convene in Chicago during the week of June 25-30 in connection with a Century of Progress Exposition. World's Fair officials have designated this period as "Engineering Week," and one day will be known as "Engineers' Day," at which a minimum of 25,000 engineers are expected to attend. The plan is for various societies to hold individual or joint meetings of their own groups except for "Engineers' Day," when all groups will join in a giant conference. Outstanding engineers of this and other countries will appear on the program to report newest developments in their respective fields. Coincident with the speaking program there will be held an exposition of power and engineering machinery and appliances in keeping with the size and importance of the gathering. Approval of participation has already been given by 19 engineering associations, either by their national headquarters, or through their Chicago chapters.

A.I.E.E. Winter Convention Technical Program Announced

PLANS for the technical program tentatively arranged for the coming winter convention of the American Institute of Electrical Engineers, to be held in the Engineering Societies Bldg., New York, N. Y., from Jan. 23-27, has been announced. Inspection trips, presentation of the Edison medal, and entertainment features for both men and women are being arranged as well. Included in the technical papers are:

"Pipe Line Pumping and Automatic Control" by John Fies; "The Principle of Condenser Discharge Applied to Central Station Control Problems" by F. H. Gulliksen; "Principles of the Direct-Selection System of Supervisory Control" by M. E. Reagan; "Operating Experience with Automatic and Supervisory Control" by J. A. Noertker; "Low-Frequency Self-Exciting Commutator Generator" by J. I. Hull; "Some Factors Affecting Temperature Rise in Armatures of Electrical Machines" by C. J. Fechheimer; "Parallel Operation of A-C Generators—Action of Governors and Damper Windings" by M. Stone; "Synchronous Motor Pulling-into-Step Phenomena" by H. E. Edgerton; "Light Sensitive Industrial Process Control" by J. V. Alfriend, Jr.; "A Standard of Low Power Factor" by W. B. Kouwenhoven and L. J. Berberich; "Protection of Electrical Apparatus—Recommended Practice, Relay Subcommittee" by O. C. Traver; "A Sequence Relay for Network Protectors" by H. S. Orcutt and M. A. Bostwick; "Phase Sequence Relaying" by H. R. Searing and R. E. Powers; "Higher Steam Pressures and Temperatures —A Challenge to Engineers" by M. D. Engle and I. E. Moultrop.

A.S.M.E. Applied Mechanics Meeting in Pasadena

AT A technical meeting under joint auspices of the Applied Mechanics Division and the Los Angeles Section of the A.S.M.E., on Jan. 20-21, at the California Institute of Technology, the following papers will be presented:

"Viscosity of Oil Saturated with Gases at High Pressures"; "Silt Analysis"; "Application of Hydrodynamical Theory to Turbine and Pump Design"; "Theory of Turbulence Pumps"; "Experiments on Fluid Resistance"; "Jet Pumps"; "Theory of Jets and Turbulent Wakes"; "Viscosity of Oils at High Temperatures and Pressures."

Free Employment Service

THE Engineers' Club of Philadelphia has for the past year sponsored the Philadelphia Technical Service Council which consists of representatives from 12 national engineering societies with the assistance of the State Employment Commission of Philadelphia. The committee handles placement, field contacts, publicity and research with the primary object of securing placement for registrants and at the same time securing for the employer the best talent available. The committee has on file applications of over 1,300 men, which are submitted to prospective employers in widely varying branches of engineering. Further information may be obtained from the Philadelphia Technical Service Committee, c/o The Engineers' Club of Philadelphia, 1317 Spruce St.

Advanced Studies for Disengaged Engineers

TO ASSIST disengaged engineers in improving their professional equipment during the Winter and Spring, engineering societies and colleges in the New York-New Jersey Metropolitan district are arranging for study courses in engineering, economic and business subjects under the auspices of The Engineering Foundation. Unemployed or volunteer teachers will conduct the engineering courses under the supervision of members of the faculties of Columbia University, New York University, Stevens Institute of Technology and the Polytechnic Institute of Brooklyn.

A.S.H.V.E. Revises Cincinnati Meeting Program

THE program of technical papers for the 39th Annual Meeting of the American Society of Heating & Ventilating Engineers, to be held under auspices of the Cincinnati Chapter at Hotel Gibson, Jan. 23-25, has been revised from that published in *Power* for December. Included in papers to be presented are:

"Study of the Application of Thermocouples to the Measurement of Wall Surface Temperatures" by A. P. Kratz and E. L. Broderick; "Some Observations on Heating Practice" by James Govan; Report of the Committee on Research by Prof. G. L. Larson; "Air Supply and Its Effect on Performance of Oil Burners and Heating Boilers" by L. E. Seeley, J. H. Powers and E. J. Tavanlar; "Effect of Cold Walls on the Desired Effective Temperature for Comfort" by F. C. Houghten; "Summer Air-Conditioning with Heat Energy—A Report on a Series of Field Tests" by E. D. Milener; "Corrosion in Air-Conditioning Equipment and Its Prevention" by R. M. Palmer; "Air Supply, Distribution and Exhaust Systems" by S. R. Lewis; "Air Infiltration Through Steel-Framed Windows" by D. O. Rusk, V. H. Cherry and L. Boelter; "Flow of Condensate and Air in Steam Heating Returns" by F. C. Houghten and Carl Gutberlet; "Condensate and Air Return in Steam Heating Systems" by F. C. Houghten and J. L. Blackshaw.

Additional committee reports, papers on residence air-conditioning and a full program of social events is also included in the plans for the meeting.

L. W. Shugg New President of Exhibitors' Committee

AT THE annual meeting of the board of directors of the Exhibitors' Committee, the following officers were elected for 1933: President, L. W. Shugg, General Electric Co., Schenectady; vice-president, C. F. Radley, Oakite Products, Inc., New York, N. Y.; secretary, H. N. Shackleford, Johns-Manville Corp., New York, N. Y.; treasurer, J. P. Ferguson, Reading-Pratt & Cady, Inc., Bridgeport, Conn.; assistant secretary, W. A. Hemming, Exhibitors' Committee, New York, N. Y.

The Exhibitors' Committee, a non-profit organization, has just completed its sixth year of work in furnishing manufacturers who exhibit with information concerning all of the larger industrial and trade shows scheduled each year. Headquarters are maintained at 330 W. 42nd St., New York, N. Y.

New York Power Engineers Plan Celebration

STEVENSON ASSOCIATION No. 44 of the National Association of Power Engineers is planning its 38th anniversary, entertainment and reception at the Yorkville Casino, 210 E. 86th St., New York, N. Y., on Saturday evening, Jan. 14, 1933, at 8:30. Admission will be $1.00. John W. Palmer is chairman. William G. Bohlinger, 41-08 30th Ave., Astoria, L. I., is secretary, and R. H. Dupre, treasurer.

New Standards

PUBLICATION of the following new standards by the A.I.E.E. is announced by the American Standards Association; American Tentative Standard for Weatherproof Wires and Cables; Tentative Standard for Heat-Resisting Wires and Cables, and Standard Definitions and General Standards for Wires and Cables.

Engineers' Council for Professional Development

SEVEN national engineering bodies have organized the Engineers' Council for Professional Development with the announced objective of advancing the professional status of the engineer. Participating bodies include: A.S.C.E., A.I.M.E., A.S.M.E., A.I.E.E., A.I.Ch.E., S.P.E.E., and National Council of State Boards of Engineering Examiners. Immediate objective of this new agency is the development of a system whereby progress of the young engineer toward professional standing can be recognized by the man himself, by the profession, and by the public through the development of those qualifications which render the engineer a valuable member of society.

Synchronous-Motor Fan Drives at Honolulu

PROBABLY the first synchronous motor applied to both induced- and forced-draft fans for central station use will be used in the new plant of the Hawaiian Electric Co., Honolulu, by Westinghouse Electric & Mfg. Co. In the past, the use of synchronous motors for power station auxiliaries has been extremely limited, partly because speed variations were not convenient. In this station the limitation is overcome on the induced draft fans for the steam boilers by coupling two synchronous motors of different operation speeds to one fan. The use of two motors to obtain required operating speeds is justified over a single variable-speed induction motor when the operating efficiencies are considered.

A type of fan will be used in which capacity may be varied within limits when operating at constant speed without an unfavorable effect on the fan efficiencies. Induced draft fans will be driven by a 300-hp., 100-per cent power factor, 600-r.p.m. synchronous motor and a 700-hp., 100-per cent power factor, 900-r.p.m. synchronous motor coupled to one fan. For normal operation the 300-hp., 600-r.p.m. motor will be sufficient but peak loads will be met by using the higher speed 700-hp. motor to drive the fan. In the same station, forced draft fans for the boilers are driven by 200-hp., 100-per cent power factor, 1,200-r.p.m. synchronous motors coupled direct. Westinghouse is also furnishing the motor control and a 10,000-kw., 11,000-volt turbine generator and switchboard for the same plant. Total value of the contract is more than $200,000.

COMING MEETINGS

American Institute of Electrical Engineers—Winter convention, Engineering Societies Bldg., New York, N. Y., Jan. 23-27. H. H. Henline, acting secretary, 29 West 39th St., New York, N. Y.

National Marine Engineers' Beneficial Assn.—58th annual convention, Lee House Hotel, Washington, D. C., Feb. 13-17. A. L. Jones, secretary treasurer, 313 Machinists' Bldg., 9th St. & Mt. Vernon Pl. N.W., Washington, D. C.

American Society of Heating & Ventilating Engineers—39th annual meeting, Hotel Gibson, Cincinnati, Ohio, Jan. 23-25, 1932. Headquarters, 51 Madison Ave., New York City.

London Machinery Exhibition Planned in September

THE date of the Twelfth Shipping, Engineering and Machinery Exhibition has been fixed for Sept. 7-23, 1933, at Olympia, London, England. Applications for copies of the official bulletin, giving advance particulars of the principal exhibits, and published in English, French and Spanish, should be made to F. W. Bridges & Sons, Ltd., Grand Bldg., Trafalgar Square, London, W.C.2, England.

Air-Conditioning Course

THE University Extension Division of Rutgers University has announced a new home-study course in air-conditioning. In 12 sections, the course directed from the University campus in New Brunswick, N. J., encompasses for the student of heating and ventilating the major principles of the scientific preparation and treatment of air in large and small systems, especially those in industrial buildings, offices, public buildings, and homes. The nominal fee includes all text material, lesson assignments, and correction service. Address the University Extension Division, Rutgers University, New Brunswick, N. J.

POWER'S HISTORY

POWER was founded in 1884 by E. P. Harris and H. M. Swetland. With it was incorporated *Steam*, which had been started by N. Hawkins in Chicago two years earlier.

In 1903 *Power* purchased and absorbed *Science and Industry*, which was a consolidation of a number of periodicals, namely, *Home Study Magazine, Home Study for Machinists, Mechanic's Magazine, Home Study for Building Trades, Building Trades Magazine, Home Study for Electrical Workers* and *Steam Electric Magazine.*

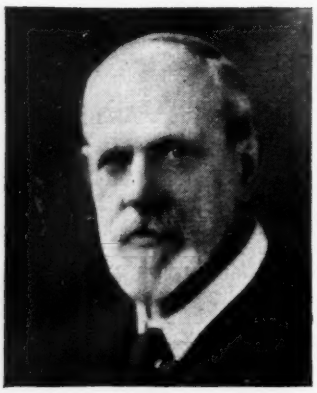
In 1908 it absorbed *The Engineer's Review*, of Cleveland, and *The Engineer*, of Chicago, the latter being a consolidation of *The Safety Valve, Lord's Power and Machinery Magazine, The Stationary Engineer, Engineers and Power Users Magazine, Steam Engineering* and *The Mechanical Engineer.* When *The Engineer* was purchased the name of the combined paper was *Power and The Engineer.* The title was condensed to *Power* in 1911.

Ownership of *Power* passed from E. P. Harris to H. M. Swetland and James H. McGraw, then to John A. Hill; and with the consolidation of the Hill Publishing Company and the McGraw Publishing Company, in 1917, it became the property of the McGraw-Hill Publishing Company.

Robert Grimshaw was the first editor of *Power.* Subsequent editors for short periods were George L. Fowler, A. D. Risteen and Franklin Van Winkle. F. R. Low was editor from 1888 until Dec. 31, 1929.

The present staff consists of Ely C. Hutchinson, editor; F. R. Low, editor emeritus; P. W. Swain, F. A. Annett, R. B. Purdy and E. J. Tangerman, editorial staff.

OBITUARIES



WILLIAM HENRY PATCHELL, 70, internationally known consulting mechanical and electrical engineer of Beckenham, England, died there Nov. 24. Mr. Patchell slipped and fell down the stairs of his home, fracturing his thigh so badly that it could not be set and inflicting other injuries, which caused his death through septic poisoning.

Mr. Patchell was actively engaged in the transformation of British power from D.C. to A.C. and in the development of large generating stations. In later years he gave his attention to the electrification of mines, but never lost touch with the supply side of the electrical industry.

He served a 5-year engineering apprenticeship with Robey & Co. of Lincoln, England. He superintended several of that company's arc lighting installations, was manager of the Electrical Power Storage Co. works at Millhall, and later took up central station work, during which he installed at Bow the then world's largest boilers. He became a consulting engineer in 1906 and in that capacity was retained by several of the Edison Companies in America. He was thus a frequent visitor to this country, a fellow of the A.I.E.E. and a member of several American engineering societies. He was a past president of the Institute of Mechanical Engineers, British National Committee of the World Power Conference and the British Engineering Standards Committee and of leading British technical societies.

SIR DUGALD CLERK, 79, pioneer and authority on the internal combustion engine, died Nov. 12 at his home at Euhurst, Surrey, England. He was a director of the National Gas Engine Co., Ltd., and a partner in Marks & Clerk, patent agents. The Clerk cycle, now known as the two-stroke cycle, was one of his developments in 1881. He was a member of many learned societies and had served as president of several. He was chosen president of the Institution of Civil Engineers this year, but his failing health prevented him from taking office.

EDWIN MUSSER HERR, 72, vice-chairman of the Westinghouse Electric & Mfg. Co. since 1929 and an outstanding figure in the electrical manufacturing industry for many years, died Dec. 24 at his home in New York after a long illness. Before becoming vice-chairman, Mr. Herr had held executive positions in the Westinghouse company since George Westinghouse asked him in 1898 to become general manager of the Westinghouse Air Brake Co. He was president of the company from 1911 to 1929.

HUBERT E. COLLINS, 60, consulting engineer, who had written a number of articles for *Power*, died at his home in Utica recently.

SEABURY SMITH GOULD, 44, vice-president of Gould Pumps, Inc., Seneca Falls, N. Y., died at his home there Nov. 25, 1932, of pneumonia.

DR. ALLAN DOUGLAS RISTEEN, 66, director of technical research and editor of safety publications for the Traveler's Insurance Co., Hartford, Conn., died Dec. 30 there. Dr. Risteen was an author of nationally known text on technical subjects, particularly on safety engineering, and was at one time editor of *Power* and at the same time an associate editor of the Century Dictionary. Subsequently he became associated with Hartford Steam Boiler Inspection & Insurance Co., and acted as editor of "The Locomotive." He joined Travelers as director of technical research in 1911. He was a member of the A.S.M.E., American Association for the Advancement of Science, V.D.I., National Safety Council and various foreign companies and also was scheduled to be representative of the American Welding Society at the Congress of Engineers in Tokio 1928. Illness prevented his acceptance.

WILLIAM B. MCVICKER, 70, president of W. B. McVicker Co., Brooklyn, N. Y., and for some years eastern manager of Dearborn Chemical Co., died Dec. 28 after he had been found unconscious in his home. His company manufactures chemicals and boiler-water treatments.

BRIG. GEN. JOHN J. CARTY, 71, retired vice-president and chief engineer of the American Telephone & Telegraph Co., New York, died Dec. 27 in Johns Hopkins Hospital of cardiac complications that followed an operation.

FRANK H. COLE, 60, inventor and engineer of West Newton, Mass., and for the past four years superintendent and manager of the Boiler Appliance Co., Watertown, Mass., died some time ago. He invented the King Cole tube cleaner.

JOHN TRIX, 84, president of the American Injector Co., and the Chace Valve Co., Detroit, Mich., and vice-president of the Steere Engineering Co., at one time, veteran manufacturer and inventor, died at his summer home in Algonac, Mich., Nov. 10. Some years ago he became interested in a patent for an injector which led to formation of the American Injector Co., Detroit, in 1886. He was one of the organizers and early presidents of the American Supply & Machinery Manufacturers' Association, was a director of the Michigan Manufacturers' Association and vice-president of the National Manufacturers' Ass'n.

PERSONALS

J. KAYE WOOD has been elected vice-president and chief engineer of the newly formed General Spring Corp., 11 W. 42nd St., New York, N. Y. Mr. Wood will also resume his practice as consultant in mechanical and structural engineering, particularly in problems in the design and manufacture of mechanical springs and spring suspensions for power-plant piping, automatic machines and equipment, and also in solution of mechanical problems by models. Mr. Wood has been chairman of the special A.S.M.E. Research Committee on Mechanical Springs for the past seven years.

E. J. HAYDEN, central division manager of the Linde Air Products Co., Chicago, Ill., was elected president of the International Acetylene Association at its annual business meeting in Philadelphia recently. H. B. Pearson, Compressed Industrial Gases, Chicago, was elected vice-president, to succeed Mr. Hayden.

WALTER F. PERKINS, formerly manager of the Harrison, N. J., works of the Worthington Pump & Machinery Corp. since 1927, has resigned to become vice-president and general manager of the Bartlett Hayward Co., Baltimore, Md. Hugh Benet, formerly manager of the Worthington's Holyoke, Mass., works, becomes works manager at Harrison.

W. POOLE DRYER, authority on engineering and economies of steam turbine plants, has been added to the staff of Arthur L. Nelson Engineers, Park Sq. Bldg., Boston, Mass., power-plant consultants. He will advise on and design power installations—steam, oil and electric.

COL. OSCAR H. FOGG has been elected vice-president of the New York Edison Co.

CARL STRIPE, well known in the steam-plant field through his former identification with Westinghouse as district engineer at Pittsburgh, and later as sales and engineering executive of Combustion Engineering Corp., New York, will head the engineering activities of the Davis Coal & Coke Co. of Baltimore as assistant to the vice-president, and will have his offices in the company's New York office in the Singer building.

ELMER E. GILBERT, sales manager of the turbine department, General Electric Co., Schenectady, N. Y., retired Jan 1, after 43½ years of service with the company and the Thomson-Houston Electric Co., one of its predecessors. Mr. Gilbert directed turbine sales for General Electric for 30 years.

WILLIAM E. SCHUBERT, for the past eight years chief engineer of the Wisconsin-Michigan Power Co., Appleton, Wis., has been appointed assistant general manager.

MAPLE LEAF COUNCIL No. 64, of the Universal Craftsmen Council of Engineers, has elected the following officers for 1933: Worthy chief, J. L. Lambert; assistant chief, A. H. Gibbins; recording secretary, E. Steel; financial secretary, G. Goudie; treasurer, A. Reddoch; warden, William Adie; chaplain, A. Reid; guard, William Geddes; outer guard, A. S. Easson. The council meets at 1023 St. Catherine St. West, Montreal, Que., every first and third Tuesday.

The Port Washington power plant of Milwaukee (Wis.) Electric Railway & Light Co., as it appeared Nov. 23. Boiler pressure, will be 1,390 lb. and steam temperature 840 deg. F.

STRAWS

Pointing the way the business wind blows

Total appropriations reported by individual chairmen of the district committees of the National Committee on Industrial Rehabilitation Dec. 16 totaled $128,000,000. This amount included everything reported to them in the way of expenditures for rehabilitation irrespective of whether or not they were the results of the committee's efforts. Items in the power plant field previously unreported include:

Sixth Federal Reserve District

Service Laundry Co., Inc., complete new laundry and building $150,000; D. H. Holmes Co., air conditioning equipment $100,000; Krauss Co., air conditioning equipment $75,000; Cloverland Dairy, refrigerating equipment, $15,000; Maison Blanche Co., air conditioning, $200,000.

Eighth Federal Reserve District

City of St. Louis, replacement of old boilers, pumps, etc., with structural changes in waterworks systems, $404,000; a new alternator, boiler and stack at City Sanitarium, $432,000; installation of new elevators at City Hospital $10,000; Kroger Grocery & Baking Co., installing oil burning equipment in boilers in place of coal to reduce smoke nuisance, $50,000; Home Ice Cream & Ice Co., new machinery and installation of stokers and boilers, $15,000; City of Hannibal, boilers and stokers at light plant, $50,000.

Fourth Federal Reserve District

Fordyee Woolen Mills, Inc., are completing installation of steam engine, press and shear, $12,000; Buckeye Coal Co., modernization of coal handling equipment, $125,000; Cosgrove-Meehan Coal Corp., power plant, rolling stock and lamps, $500,000.

Twelfth Federal Reserve District

Pacific Bone Coal & Fertilizer Co., addition to power plant, $25,000; Hawaiian Elec. Co., addition to power plant, $750,000.

The office of the Supervising Architect of the Treasury Dept., Washington, D. C., will open bids Jan. 6 for furnishing materials and performing the work on a complete elevator plant in the U. S. Post Office, Court House, Tyler, Texas.

A proposal that the City of Portland, Ore., construct its own generating plant for supplying street lights and electrical energy to municipal and county buildings has been made by consulting engineers there. The report suggests a steam or diesel generating plant of 7,500 kw. capacity and distribution system to cost approximately $1,700,000. Such a plant is expected to result in a saving of practically 40 per cent on present costs.

Bureau of Reclamation of Denver, Colo., is asking until February 3 for bids for three, four or five vertical-shaft hydraulic turbines (115,000 hp.); for one or two similar hydraulic turbines (55,000 hp.), for Hoover Dam power plant, Boulder City, Nev.

Work has been commenced on the Goat River development of the West Kootenay Power & Light Co., near Nelson, B. C., according to Lorne A. Campbell, vice-president and general manager. Building of the compressor house and camp buildings has progressed rapidly, and construction of the cofferdam, to divert the water from the river during development operations, can be started soon. This development will supply power to the Creston district.

Oberlin, Ohio, is having plans drawn for city-owned electric plant and has authorized a bond issue of $250,000.

Freehold and qualified voters of Radford, Va., at the polls have approved the city council's proposal to issue municipal bonds to the amount of $150,000 for the construction of a hydro-electric plant on Little River. The plant is expected to be begun immediately.

Westinghouse Electric & Mfg. Co., received a $150,000 order for electrical metering and switching equipment in Cincinnati's new $41,000,000 railroad terminal.

Electric pumps, transformer equipment, panelboards, etc., will be used in the 80-mile pipe line of the Pure Oil Co. and Sun Oil Co. from Toledo to Detroit. A $500,000 project.

Appalachian Power Co. is planning a hydro-electric project on New River, near East Radford, Va. It will cost approximately $12,000,000.

York Ice Machinery Corp., York, Pa., has received orders for the refrigerating equipment to be used in air-conditioning the new U. S. Department of Justice Bldg., and also for the new U. S. Post Office Bldg., in Washington. The Department of Justice refrigerating system is the largest single installation of refrigerating equipment for air-conditioning under one roof in the world. It is equivalent to the melting of 2,000 tons of ice a day. Three large Freon compressors will be used. The three refrigerating machines in the post office building will supply the equivalent refrigerating effect of 1,450 tons of ice per day.

Reconstruction Finance Corp. has approved a loan of $1,621,000 to the Seattle, Wash., Light Department, to complete the City Light Building and the Diablo power house, and has refused a $1,000,000 loan to extend the City Light distribution system inside the city.

Rust Engineering Co., Pittsburgh, submitted the low bid for construction of the new central heating plant in Southwest Washington, D. C. A bid of $1,489,900.

Power generating machinery excepting electric and automotive machinery was one of the two machinery items which showed a November increase in exports over October. The other was power-driven metal-working machinery. Power-generating machinery was exported in November to a value of $329,705, as compared with $296,712 in October and $525,256 in November, 1931. Electrical machinery exported in November totaled $3,697,630, as compared with $3,889,807 in October and $5,677,646 in November, 1931.

Fort Wayne, Ind., is asking bids until Jan. 5 for equipment for a city-owned electric plant.

The Vernon (Calif.) Brewing Co. is soon to spend about $160,000 for motors, machine drives, electric pumps, refrigerating equipment, transformer equipment, switchboard panels, etc.

Empire District Electric Co. has been awarded a Federal Power Commission major license for a project on White River, Mo. The application for this license was pending for more than eight years before the predecessor commissions. The project includes a dam across White River at Table Rock in Taney County near the Arkansas line and when completed, the project, with the necessary substations and transmission lines will involve an expenditure of thirty million dollars and generate 200,000 hp.

The city of Danville, Va., has under consideration a request from the city of Martinsville, Va., for power at such times that its plant cannot generate sufficient current for the city's needs.

Villisca, Ia., is asking bids until Jan. 10 for a diesel-engine generating unit, switchboard, transformers and similar equipment for a city-owned plant to cost about $150,000.

Heavy-duty motors, regulators, transformers and electric pumps will be installed in a new pumping station in Chicago to cost $2,327,000.

New Bulletins

SURFACE CONDENSERS—A bulletin, Form 9227, issued by Ingersoll-Rand Co., 11 Broadway, New York, N. Y., illustrates many of its condenser installations, ranging from small units up to those of 160,000 kw. capacity. Features include single- and two-pass construction, heart-shaped shell, external air coolers, longitudinal steam distribution, and tube-sheet arrangement. Separate sections are devoted to small condensers, steel-plate condensers, and marine condensers.

WIRE ROPE SLINGS—John A. Roebling's Sons Co., Trenton, N. J., has issued a bulletin on "Roebling Wire Rope Slings," giving drawings, illustrations and listing complete specifications for these products of the company.

EMPLOYEES' SUGGESTION SYSTEMS—The Policyholders Service Bureau, Metropolitan Life Insurance Co., 1 Madison Ave., New York, N. Y., has issued a bulletin under the above title which collects and analyzes data on the plans of more than a hundred companies, and describes features of these plans. A limited number of copies are available for distribution.

WELDING—"Weld It Well," a bulletin of Harnischfeger Corp., 4400 W. National Ave., Milwaukee, Wis., describes latest developments in welding practice and welder design and shows the new models of P&H Hansen arc welders as well as standardline.

BELTING—"Lubricated with Rubber" is the title of a four-page booklet on its "Highflex" belting just issued by The B. F. Goodrich Rubber Co., Akron, Ohio.

FLUID METERS—Bulletin No. 300 of Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland, Ohio, describes in its 24 pages the new line of Bailey fluid meters, illustrating types and giving application and methods of installation.

PACKINGS—Catalog B-1932 of the Garlock Packing Co., Palmyra, N. Y., has just been issued. It contains 157 pages, 9x12 in., illustrating in colors the various types of gaskets and packings. The catalog is bound in clothboard covers, is extensively illustrated, indexed, and contains a list of Garlock distributors and dealers.

PORTABLE DRAFT GAGE SETS—Ellison Draft Gage Co., 214 W. Kinzie St., Chicago, Ill., has issued Bulletin No. 15 describing the new Ellison portable draft gage sets, Series 35, including a chapter on how to use a draft gage in domestic heating plants.

PREHEATERS—The Air Preheater Corp., Wellsville, N. Y., has issued Bulletin No. 932 on the Ljungström air preheater entitled, "Something to Think About Before Buying the Next Boiler," describing savings obtained by application of a preheater.

SOOT BLOWERS—Diamond Power Specialty Corp., Detroit, Mich., has issued Bulletin No. 144, "Ships and Soot," and Bulletin No. 836 on the company's line of soot blowers recently described in the plant equipment section of *Power*. "Ships and Soot" is a 24-page, well-illustrated bulletin, showing applications of soot blowers in marine service.

RECORDING THERMOMETERS—C. J. Tagliabue Mfg. Co., Park & Nostrand Aves., Brooklyn, N. Y., has issued Bulletin No. 1040, describing the company's new miniature-size recording thermometer and square-case dial-indicating thermometer.

SWITCHBOARD INSTRUMENTS — Westinghouse Electric & Mfg. Co., Newark, N. J., has issued a bulletin on Type H switchboard instruments of the a.c. and d.c. radio-frequency and rectifier types.

SUPERVISORY CONTROL — Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has issued circular C. 1948 describing the operation and construction of the "Polaricode" split-second supervisory control described in *Power* in August.

V-BELT DRIVES—Catalog No. 105 of The Dayton Rubber Mfg. Co., Dayton, Ohio, contains complete information on Dayton Cog-Belt Drives and includes information on Day-Steel pulleys and a card for rapid determination of proper belt size. Complete prices and dimensions are included, as well as simplified data for calculation of special drives where required.

VACUUM HEATING PUMPS—Type "F" Low-Return Ames Vacuum Heating Pumps of the Ames Pump Co., Inc., 30 Church St., New York, N. Y. (division of American Locomotive Co.) are described in Bulletin No. 700, which gives illustrations and specifications for these units. Type "E" pumps of the same company are described in Bulletin 600.

New Plant Construction

McGraw-Hill Business News Department Is Prepared to Furnish a More Complete Daily Service

Ark., Mena—Committee, c/o G. W. Petty, Mena, plans electric power plant. $75,000.

Ark., Paragould — City, election Jan. 31, $100,000 complete electric light and power plant. W. A. Fuller Co., Shenandoah Ave., St. Louis, Mo., engrs.

Calif., Los Angeles—Los Angeles Co. plans improvements to power plant to include steam piping and alterations for new boilers: new 130 ft. smokestack, 10½ ft. diam. at bottom and 6 ft. at top walls 9⅛ in. thick at bottom tapering to 4 in. at top, at General Hospital Grounds. W. Davidson, Hall of Records, co. mechanical engr.

Calif., Los Angeles — Bureau of Power & Light, 2nd St. and Bway., sketches by F. L. Roehrig, 35 South Raymond Ave., Pasadena, 1 story, 50 x 130 ft., rein.-con., brick power substation, Durengo, Canfield and Tinkerdine Sts., Palms Dist. To exceed $28,500.

Calif., Pasadena—Pasadena Municipal Light & Power Dpt., acquired site and plans 380 x 416 ft. substation at Lamanda Park, North Santa Anita Ave. $190,000. G. K. Hooper, city engr. Estimates have been made for cost of central substation on property acquired several years ago in Skillen Alley also for extension of power plant and North Raymond Ave. substation. Altogether it is estimated that $638,575 will be required for substations.

Calif., San Luis Obispo — O. Thompson, Security 1st Natl. Bank, Los Angeles, plans irrigating 77 acres, involving 600 g.p.m. pumping plant, 7,400 lin.ft. 10 in. concrete pipe. Work starts Feb. 1.

Colo., Colorado Springs—City Council, E. L. Mosley, mgr., plans completing steam plant and additions, betterments to lighting plant system in 1933. $84,000 budgeted for same.

Fla., Lake City—Bids Jan. 17, by Vet. Bu., Arlington Bldg., Wash., D. C., clinical building, boiler house, and officers' quarters at Veterans' Administration Hospital.

Ga., Macon—City, c/o Mayor, sketches light and power plant, incl. equipment, distribution system. Burns & McDonnell Eng. Co., 406 Interstate Bldg., Kansas City, Mo., engrs.

Ga., Nahunta—Brantley County Utilities Co. plans electric generating plant. $30,000 or more.

Ga., Valdosta—P. C. Pendleton, mayor, appointed committee, Councilmen A. A. Parrish, L. J. Miller and B. S. Richardson to consider proposition from engineering firm to rehabilitate city water plant, securing funds from Reconstruction Finance Relief Corp. Plans under consideration include new oil burning engine, new pumps, elevated tank, dynamos and necessary machinery together with additional deep well. Cost not to exceed $102,000 on a guarantee.

Ill., Belleville—Executive Com. adopted resolution approving survey costs made by Pearse, Greeley & Hansen Hydraulic and Sanitary Eng. Co., 6 North Michigan Ave., Chicago, for various types municipal waterworks projects, incl. valuation of East St. Louis and Interurban Water Co., a proposal to build municipal light and power plant in conjunction with waterworks was placed before committee by 2 members. $1,500,000 for waterworks and $750,000 for light plant.

Ill., Chicago—Western Cold Storage Co., 208 West Washington Blvd., plans altering and repairing warehouse, 439 East South Water St. $30,000. Engineer and architect not selected.

Ill., Chicago—Wilson & Co., 4100 South Ashland Ave., plans replacing boilers and machinery in old building. Total est. $600,000.

Ill., Chicago—Sears, Roebuck & Co., Arthington and South Homan Ave., plans boiler plant addition. $250,000. M. Roberts, ch. engr., looking into all models of machinery and materials and would welcome information and suggestions.

Ill., Collinsville—City revising plans several miles 8- to 21-in. sewers, sewage pumping plant, disposal plant, etc. $250,000. Kinsey Eng. Co., 515 Court St., Pekin, engrs.

Ill., Marseilles—U. S. Eng., 333 North Michigan Ave., Chicago, preparing plans boiler houses and installing equipment to heat taintor gate plates in Dresden Island and Starved Rock Dams, part of Lake to Gulf Inland Waterway, maturity in 60 days.

Ind., Hammond—Cities of Hammond, Whiting and East Chicago plan tri-city municipal power plant. $250,000.

Ia., Villisca—City voted to build, maintain and operate municipal electric light and power plant. $150,000.

Kan., Burlington—City, C. S. Wingett, mayor, sketches municipal light and power plant. E. T. Archer, 609 New England Bldg., Kansas City, Mo., engrs.

Mich., Adrian—Municipality plans light and power plant. To exceed $30,000.

Mich., Frankfort — Village retained Francis Eng. Co., engrs., Saginaw, to prepare preliminary plans and estimates for municipal light and power plant and electric distribution system. $35,000.

Mich., Ludington—City received report from Burns & McDonnell Eng. Co., engrs., 406 Interstate Bldg., Kansas City, Mo., on light and power plant. $337,200. Maturity soon.

Mich., Milan—Village making plans extensions to waterworks, incl. pumping equipment and watermain extensions to supply new Federal Prison (under construction). $15,000. Boulay-Harrison Co., 12½ Broadway Ave., Toledo, O., engrs.

Minn., St. Paul—City plans municipal light plant. Burns & McDonnell Eng. Co., 400 Interstate Bldg., Kansas City, Mo., engrs.

Missouri—Empire District Electric Co., Joplin, subsidiary Cities Service, has formally accepted major license from Federal Power Comn. for construction hydro-electric dam and power plant on White River at Table Rock, Taney Co., near Galena, generating 220,000 hp. electric energy. $30,000,000.

Neb., Loup City—Owner, c/o J. E. Bowman, pres., Loup City, plans dam on Middle Loup River, hydro-electric plant, 1,500 kw. capacity, at dam site probably at Austin, also irrigation system. Henningson Eng. Co., 326 Union Bank Bldg., Omaha, engrs.

O., Toledo—Made plans Lake Erie water supply project pumping station intake, filter plant and pipe lines to city. W. G. Clark, city engr. Application to Reconstruction Finance Corp. for $8,000,000 loan.

Okla., Hominy—City voted to accept offer of Trans-American Constr. Co., Philtower Bldg., Tulsa, to construct municipal light and power plant, distribution lines $134,800, and to accept payments from earnings of plant after it is in operation. V. V. Long & Co., 1300 Colcord Bldg., Oklahoma City, engrs.

Pa., Phila.—Philadelphia Electric Co., 1000 Chestnut St., plans expending $10,530,000 for construction electric and power distribution during 1933. Making budget provision for same.

Va., East Radford—Appalachian Power Co., plans for hydro-electric project on New River, near here, incl. high dam, and lake to have 95 mi. shore line development, will cover 4,600 acres, 26,000 hp. generators. $12,000,000.

Equipment Wanted

WATER TUBE BOILERS—**Los Angeles, Calif.**—Los Angeles Co., completing specifications installing two 500 hp. water tube boilers for power plant, General Hospital Grounds. W. Davidson, Hall of Records, county mechanical engr.

DRAINAGE PUMPS—**Stockton, Calif.**—Plans prepared installation new drainage pumps on Mandeville and Bouldin Islands for Reclamation Dists. 756 and 2027, c/o California Delta Farms Co., Belding Bldg., Stockton. Est. $30,582 and $22,255 respectively.

PUMPING UNITS—**Wash., D. C.**—Bids Jan. 18, by U. S. Eng., erecting 4 motor driven pumping units for booster pumping station at Washington Aqueduct, north end of Dalecarlia Reservoir. Former bids rejected.

MOTOR, etc.—**Chicago, Ill.**—City, Dpt. P. Wks., furnishing, designing, erecting 1 motor for 22nd Street Pumping Station, and repairing turbo-generator at Municipal Power Plant. M. Reynolds, city engr.

PUMPS—**Joliet, Ill.**—U. S. Eng., 333 Michigan Ave., Chicago, plans portable lock dewatering pumps, vertical irrigation on Illinois Waterway. Maturity spring.

HYDRAULIC TURBINES—**Las Vegas, Nev.**—Feb. 3, by Bureau Reclamation, Denver, Colo., three to five 115,000 hp., and one or two 55,000 hp. vertical shaft, hydraulic turbines, with or without butterfly type shutoff valves; 3 to 5 governors for 115,000 hp., and 1 or 2 governors for 55,000 hp. turbines, for installation in Hoover Power Plant, Boulder Canyon Project, Arizona-California-Nevada.

PUMPS, etc. — **Winston-Salem, N. C.** — City soon takes bids pumps and materials for pumping station, for sewerage extension. G. W. Coan, mayor.

CENTRIFUGAL PUMP—**Lakewood, O.**—City soon takes bids centrifugal pump with electric motor for sewage disposal plant.

DIESEL ENGINE — **Coraopolis, Pa.** — Bids Jan. 17, by Boro Secretary, Municipal Bldg., furnishing, setting place 1 full Diesel engine, 180 hp., directly connected to generator and exciter on crank shaft in main pumping station of waterworks.